REPORT

REEVALUATION OF THE PRACTICABILITY OF THE LAKE ERIE-OHIO RIVER CANAL

STATE PLANNING BOARD
COMMONWEALTH OF PENNSYLVANIA
HARRISBURG, PA.

JUNE 25, 1965

Ford, Bacon & Davis
Incorporated
Engineers
CHICAGO NEW YORK SAN FRANCISCO

REPORT

REEVALUATION OF THE PRACTICABILITY OF THE LAKE ERIE-OHIO RIVER CANAL

STATE PLANNING BOARD
COMMONWEALTH OF PENNSYLVANIA
HARRISBURG, PA.

JUNE 25, 1965

Ford, Bacon & Davis
Incorporated
Engineers

CHICAGO NEW YORK SAN FRANCISCO

Contents

Contents

Contents

ESTABLISHED 1894

(COPY)

Ford, Bacon & Davis

Incorporated

Engineers

CHICAGO CONSTRUCTION VALUATIONS REPORTS MANAGEMENT SAN FRANCISCO

2 BROADWAY
NEW YORK, N.Y. 10004

New York, June 25, 1965

State Planning Board
Commonwealth of Pennsylvania
Office of the Governor
Harrisburg, Pa.

Dear Sirs:

At your request, we have reviewed a report issued January 1965 by the U.S. Army Engineer District, Pittsburgh, Corps of Engineers, Pittsburgh, Pa., entitled "Review of Reports on Lake Erie - Ohio River Canal."

In our opinion, the total construction cost estimate is understated, major benefits are overstated, and there are several areas which appear to be questionable, as follows:

1. Estimated construction cost of waterway is understated by at least $186,000,000.
2. Fairport Harbor and necessary user terminal facilities would add construction costs of $123,000,000.
3. Realistic interest rates would add $18,000,000 annually.
4. Average annual transportation benefit should be reduced from $68,500,000 to $44,070,000.
5. Average annual recreation benefit should be reduced from $22,800,000 to $4,200,000.
6. Flood control benefits are accepted, but the expected reduction in flood level in the Pittsburgh District is not supported.
7. Method for deriving average annual benefit is questionable.

We believe the project is impracticable as the estimated benefits of $57,000,000 are $15,200,000 less than the Federal and non-Federal charges of $72,200,000, resulting in a benefit-to-cost ratio of 0.8 to 1.0. The accepted standard for project approval is a 1:1 or better ratio.

Furthermore, while there would be some benefits to a few large industries and some citizens of the Commonwealth of Pennsylvania, the disadvantages suffered by the remainder of the industries and taxpayers would far outweigh the advantages.

Very truly yours,

(signed) FORD, BACON & DAVIS, Inc.

PURPOSE AND SCOPE

In accordance with an accepted proposal dated March 25, 1965 Ford, Bacon & Davis, Inc. ("Engineers") was engaged by the State Planning Board ("Planning Board") of the Commonwealth of Pennsylvania to make a reevaluation study and to report whether a Lake Erie-Ohio River Canal following the Beaver-Mahoning-Grand Rivers route now appears practicable, and if so, the indicated effect of such a canal on the future economic posture of the State of Pennsylvania.

This report is based on a review of the document entitled: "Review of Reports on Lake Erie-Ohio River Canal, Pittsburgh-Ashtabula Route via Beaver-Mahoning-Grand River Valleys" ("Hammer Report") issued January 1965 by the U.S. Army Engineer District, Pittsburgh, Corps of Engineers, Pittsburgh, Pa., ("Army Engineers") and analyses of other material related to the subject, including a certain amount of field investigation.

Initial costs of the project as estimated by the Army Engineers have been reviewed, as have annual maintenance and operating expenses of the waterway and the cost of furnishing water transportation. Potential traffic has been analyzed giving consideration to the St. Lawrence Seaway, progressive economic development in Canada, and industrial expansion in western Pennsylvania incident to any extension of inland waterway transportation. The advantages and disadvantages to Pennsylvania have been assessed on the basis of their impact on the Commonwealth's present industries and working population together with possible navigation, recreation, flood control, and Area Redevelopment Administration benefits.

PROCEDURE

The Engineers reviewed the January 1965 Hammer Report and studied the developments on the proposed canal since the report appearing in House Document No. 178 of the 76th Congress, First Session (February 1939) and the so-called Lorence Report written in 1947 on the economic feasibility of the Beaver-Mahoning Rivers route were published. The public hearings on the project held at Pittsburgh,Pa., and Jefferson, Ohio, in October 1964 were attended and statements therein presented were reviewed. A physical inspection of the proposed route was made and conferences were held with representative potential users of the canal to learn the extent to which Pennsylvania industries might use the project.

Inquiries were made in western Pennsylvania of the present-day costs of floating equipment, and information relating to current towboat and barge operating costs and procedures was obtained.

Reports by various government and private agencies were studied as a basis for estimating potential canal traffic, transportation rates, and sources and destinations of tonnage to be considered as canal traffic. For determination of raw materials requirements for blast furnaces and historical usage of these materials, the Engineers consulted the Annual Statistical Reports of the American Iron and Steel Institute and The Iron and Steel Works Directory published by the same organization. To evaluate the potential canal traffic in coal for thermal power and for delivery to the lower Lake ports for transshipment to other Lakes ports for metallurgical, thermal power, and other industrial and commercial uses, works consulted were the National Power Survey prepared by the Federal Power Commission in 1964, and Reports of

the Ore and Coal Exchange of Cleveland, Ohio. Transportation rates were studied in such works as the Report to the Panel on Civilian Technology on Coal Slurry Pipelines, Interstate Commerce Commission Reports, and Form A Reports from several railroads operating in the canal area. In addition to the above, various reports and studies from the Engineers' files were used as reference material.

HISTORY

An all-Pennsylvania canal between the Ohio River and Lake Erie was constructed between 1831 and 1844 and was operated until 1871, when the collapse of an aqueduct proved too great an obstacle to overcome in the face of increasing railroad competition. Constructed in part by the Commonwealth and in part by private capital, it was operated by the Erie Canal Company. This canal followed the Beaver and Shenango Rivers to Conneaut Lake and thence to the port of Erie.

The Covell Report

Over the last 85 years the Army Engineers have made numerous studies of a Lake Erie-Ohio River canal via at least five different routes. The so-called Covell Report in 1939, House Document No. 178, 76th Congress, First Session, reduced practicability of construction to two routes: the Beaver-Mahoning Rivers and the Allegheny River-French Creek. However, the report concluded that only the first would have possible economic feasibility.

The estimated first cost of the Beaver-Mahoning Rivers project was $178,965,000, divided $152,039,000 to the Federal Government and $26,926,000 to "local interests" unspecified. The Board of Engineers for Rivers and Harbors in forwarding the report to the Chief of Engineers noted that if rail rates were reduced an average of 29 cents a ton the through-canal project could not be justified. The Interstate Commerce Commission advised that the railroads had ample capacity to carry any traffic likely to develop in the area, that a canal might result in the diversion of 56,000,000 tons of rail and highway traffic with a consequent revenue loss of about $35,000,000, and that the general public had a vital interest in protecting the revenues of transportation

agencies whose services are available the year around and to large and small shippers on equal terms.

The Congress took no action on the Covell Report.

The canal project remained dormant during World War II, but on July 20, 1946 the Committee on Rivers and Harbors of the U.S. House of Representatives passed a resolution directing the Board of Engineers for Rivers and Harbors ("Board of Engineers") to review the reports on the Lake Erie-Ohio River Canal with a view to determining the current estimate of costs and benefits for the Pittsburgh-Ashtabula route which was recommended in Covell Report, including consideration of advisability of providing a project depth suitable for both lake and river traffic.

The Lorence Report

In 1947, the then District Engineer at Pittsburgh, Colonel Walter E. Lorence, completed a review of the Covell Report. The Lorence Report recommended using the so-called Pittsburgh-Ashtabula route, following the Beaver and Mahoning Rivers to Warren, Ohio, thence via open cut into the Grand River Valley which would be dammed to create Summit Reservoir almost 60 miles long and from 4 to 6 miles wide. From a point near Austinburg, Ohio, the canal would descend to a terminus on Lake Erie about 2 miles west of the present harbor at Ashtabula.

The Lorence Report suggested basic variations from the Covell Report, one of which moved the descent to Lake Erie from the northwest to the northeast corner of Summit Reservoir, thereby bringing the Lake Erie terminus close enough to Ashtabula harbor to be incorporated in the latter's breakwater. Another variation increased the channel depth from 12 to 18 ft so that barges could be loaded to a depth of 14 rather than 9 ft. Lock capacity was expanded by substituting dual locks 60 ft by 635 ft for previously proposed single locks, 56 ft by 720 ft. A minimum bottom width

of 226 ft was proposed except for about 9 miles through Youngstown where the maximum bottom width would be limited to 200 ft.

Estimated Cost

The 1947 estimated first cost was $439,348,000, of which the Federal portion was $416,454,000 and the non-Federal interest was $22,894,000. Corresponding annual charges were estimated as $20,818,000, the Federal proportion being $19,595,000 and the non-Federal $1,223,000.

Based on prospective traffic of 36,714,000 net tons, the Army Engineers estimated annual navigation benefits in the amount of $24,455,000, which was determined by subtracting an estimated cost to the shipper of water transportation from what the shipper was currently paying to move his tonnage by rail or highway. To these calculated navigation benefits were added flood control, low water regulation, and water power potential to obtain annual benefits from the waterway of $25,290,000. The report claimed an economic ratio of 1.21 to 1, i.e., the ratio of "Estimated Annual Benefits" to "Estimated Annual Charges".

Proposed Beaver-Mahoning Rivers Canal Project - 1947

Total Estimated Annual Charges		$20,818,000
Estimated Annual Benefits:		
Navigation	$24,455,000	
Flood Control	437,000	
Low Water Regulation	142,000	
Water Power	256,000	
Total	$25,290,000	

Economic Ratio = $25,290,000:$20,818,000, or 1.21:1

Public Reception

At public hearings on the review report in Pittsburgh and Ashtabula during 1947-1948, proponents of the projected canal included the cities of Youngstown, Girard, Niles, and Warren, Ohio,

industries in these cities, and inland waterway barge operators. They maintained that the Youngstown district was entitled to water transportation for its raw materials, primarily coal, so that its industries could compete with those in the Pittsburgh district which have access to water transportation for coal deliveries. Without such a waterway, Youngstown's industrial expansion would be stifled.

The principal opponent of the project was the Upper Ohio Valley Association, whose membership includes the principal railroads serving the area, the cities of Ashtabula and Cleveland, and residents of the Grand River Valley who would be forced to vacate their premises by the creation of the Grand River Reservoir. The opponents' arguments cited the adequacy of existing agencies of transportation serving the area and indicated that the Army Engineers had underestimated the costs of the project by at least $353,000,000. Witnesses representing two of the large steel producers in the Pittsburgh district pointed out that the cost of acquiring floating equipment and rearranging their mills to receive iron ore by barge instead of by rail would exceed the savings per ton available in using water transportation.

While the report was still under review by the Board of Engineers an announcement was made in February 1949 by the River-Lake Belt Conveyor Lines, Inc., Akron, Ohio, of a plan to construct a two-way conveyor belt system from Lorain, Ohio, on Lake Erie to East Liverpool, Ohio on the Ohio River. In view of the apparent economic relationship of the proposed belt conveyor system to the canal, the Board of Engineers returned the Lorence Report to the Army Engineers for further study. The proposed conveyor system company failed to obtain right of eminent domain in Ohio and therefore has not and probably will not materialize.

The Hammer Report

The canal project was again dormant due to lack of funds and curtailed nonmilitary activities during the Korean conflict. A restudy and report on the canal project was authorized in the fall of 1961 by Congressional Directive based on the Committee on Rivers and Harbors of the House of Representatives' resolution which was passed July 20, 1946. The District Engineer at Pittsburgh, Colonel J.E. Hammer, completed his restudy in January 1965 when the current report entitled "Review of Reports on Lake Erie-Ohio River Canal, Pittsburgh-Ashtabula Route via Beaver-Mahoning-Grand River Valleys" was published. The Hammer Report forms the basis for the Engineers' report which follows.

Public Hearings

Public hearings were held early in 1962 at Youngstown, Ohio, and Pittsburgh, Pa., to acquaint the interested parties with the new study and to obtain local viewpoints.

The Engineers attended public hearings at Pittsburgh, Pa., and Jefferson, Ohio, which were held in October 1964 to afford interested parties an opportunity to make statements regarding the canal project prior to publication of the Hammer Report.

Statements by proponents and opponents of the canal project at these hearings were essentially updated versions of previous statements at the hearings on the Lorence Report in 1947-1948.

PROPOSED LAKE ERIE-OHIO RIVER CANAL

The proposed Lake Erie-Ohio River Canal following the route recommended in 1947 by the Army Engineers would provide a new navigable waterway extending about 120 miles from the junction of the Ohio and Beaver Rivers to the Lake Erie shore at the east end of Fairport Harbor. This route, shown on the map, Exhibit No. 1, follows up the Beaver River to its junction with the Mahoning, thence northwest up the Mahoning River through Youngstown to Warren, Ohio. This section would include seven dams for water level control from elevation 682 at the Ohio River to elevation 841 at Summit Reservoir.

From Warren, the canal would be constructed across country in a northerly direction to a junction with the Grand River which would be dammed to form Summit Reservoir extending to Harpersfield, Ohio. From Harpersfield, the canal would follow the Grand River in a westerly direction to Painesville and thence north via a cut to the Lake Erie shore at Fairport Harbor. Three dams would be required to provide control from Summit Reservoir at elevation 841 to Lake Erie at elevation 570.

As proposed, the waterway would have a minimum channel depth of 18 ft and a bottom width of 300 ft except in the Youngstown and Warren, Ohio, areas where restrictions along the river limit the width to 200 ft and 250 ft, respectively. Each dam would have dual 84 x 720 ft locks to accommodate tows.

Estimated Cost of Construction - 1964

Sections of the Hammer Report concerning estimates of cost of construction of the proposed canal have been reviewed by the Engineers to evaluate the several features affecting the construction cost estimate of the project. Particular attention has been given items of major expense. Quantities and unit costs have

been checked where this was possible. Detailed topographical and geological information was provided only in part, requiring some general assumptions to be made as to quantities and difficulties of the work according to the best judgment of the Engineers, or acceptance of the Hammer Report figures where these appeared reasonable. Results of this review of major items are given in the following paragraphs.

Site Preparation

Principal items included in site preparation are the removal of existing dams, the relocation of cemeteries, and clearing of the reservoir and canal sites. The Army Engineers' estimate for this work was based upon the analysis of cost data for similar work on previous projects.

The unit cost for clearing land appears adequate, and the Engineers accept the other estimated costs in this category based on the Army Engineers' experience in work of this nature.

Channel Excavation

The quantities of common and rock channel excavation were reported separately in the Hammer Report. It was stated that the quantities were computed for each pool with sections taken every 400 ft. From a large-scale profile and given or assumed sections, the combined common and rock channel excavation quantities appear reasonable. The geological profile, Beaver River to Grand River, shows substantial rock excavation required of the same order as that shown in the Hammer Report estimate for this location. These estimates of common and rock excavation therefore have been accepted.

Excavation equipment was assumed to be large-capacity draglines, shovels, and scrapers. Proposed sites for disposal were not identified in the report. While it is recognized that in some congested and confined areas relatively long-haul distances

would be required, it is assumed for the purposes of this report that over the total length of the canal, length of haul to disposal sites would not be excessive for heavy earth-moving equipment contemplated.

An analysis has been made by the Engineers of costs of common excavation and rock excavation for each of the pool sections. The tabulation below compares weighted average unit costs of channel excavation used in the Hammer Report with the Engineers' estimate, and shows the Engineers' total estimated cost of common and rock excavation at 1964 cost levels.

Estimated Cost of Channel Excavation

Item	Unit Cost (average per cu yd) Hammer Report	Unit Cost (average per cu yd) Engineers	Quantity (1,000 cu yd)	Engineers' Estimated Cost ($1,000)
Common Excavation	$0.40	$0.675	110,290	$ 74,445
Rock Excavation	1.02	1.96	37,450	73,402
Subtotal				$147,847
Contingencies, 15%				22,177
Total				$170,024

The Hammer Report total estimated cost for common and rock channel excavation for the canal was $95,035,000, including contingencies of 15%. The Engineers' estimate exceeds this figure by $74,989,000.

Highway and Railroad Bridges, and Relocations

The Hammer Report indicates that 42 highway bridges and 38 railroad bridges would be replaced or rebuilt across the proposed canal. Also, it was indicated that there would be a number of highway relocations and 16 railway raisings and relocations, totaling about 20 miles of main line trackage and numerous siding

adjustments. The same unit costs were used for concrete on all bridges, based on concrete costs of typical highway bridges. Structural steel costs were developed from a number of comparable bridges of variable sizes and types. Costs for excavation, embankments, and pavement for highways were derived from actual construction cost data. Average costs were used for relocation of roads and bridges. For railway excavation and embankment, temporary trestles and removals, costs were developed from cost of doing similar work. Unit costs for railway construction were taken from "established cost data".

The cost of bridges is dependent to a large extent on local foundation conditions and required length of clear span; details of foundation requirements were not given in the report. Costs quoted lump-sum for several items could not be checked without a more complete job description. While lump-sum prices were used for relocation of highways and railways, the cost of this work appears reasonable as, in general, average conditions apply except where the work is complicated by maintenance of traffic. It is assumed that traffic conditions were considered in the Hammer Report.

Unit costs used for basic items in the Hammer Report appear reasonable except for the cost of structural steel, where $0.23 per lb for highway bridges and $0.21 per lb for railway bridges (except one bridge at $0.23 per lb) was used. In the Engineers' opinion the unit price should be $0.26 per lb based upon the type of work involved and a review of recent prices. Some of the factors considered were the long spans required, especially for the railway bridges, the installations which would be made under traffic conditions, and spans which would be replaced in part only.

The estimates in the Hammer Report for highway and railroad bridges, and relocations, are accepted except for

structural steel, which estimated total cost for both types of bridges, including 15% for contingencies, is $59,004,000. The Engineers' comparable figure using a unit cost of $0.26 per lb is $71,175,000, or an additional amount of $12,171,000.

Locks and Dams

Estimated quantities for locks and dams were stated in the Hammer Report to be based upon subsurface investigations of foundation conditions at selected sites, and design requirements at the various locations. Unit costs for cofferdams, excavation, piling, and substructures reflect these site conditions. Unit prices of concrete were based upon cost of locks and dams now under construction. Other unit and lump-sum costs for the structures were developed by analysis of costs for similar work in the general area.

The bases for the estimates appear to be well defined. The foundation conditions, which are the big variables at the several locations, were investigated at each site. Sections for the Harpersfield Dam are shown in the Hammer Report and calculation of the concrete volume checks this estimate very closely. Rough estimates of concrete quantities made from plan views and known heights of the other dams, indicate that the quantities are acceptable for these structures.

The major cost items for locks and dams are computed from unit costs. As concrete is a principal item in these structures, special attention was given these unit costs, and, in general, they were found reasonable. For example, for the seven locks from Beaver Falls to Girard, the average cost of $21 to $22 per cu yd of concrete (exclusive of reinforcing steel and cement) is 43% of the total cost, which is within a range considered acceptable. Exception is taken to the use of a unit cost of $16 per cu yd for concrete for the Painesville Lock and the

Harpersfield and Vrooman Locks and Dams. In the Engineers' opinion, \$20 per cu yd is a more realistic figure for these structures. The additional cost due to this increase of \$4 in the unit cost for the 4,013,000 cu yd of concrete in these three locks and two dams is \$16,052,000. All other estimated costs in the Hammer Report for locks and dams are considered acceptable.

Retaining Walls

Estimates for retaining walls apparently were based on average conditions by the Army Engineers. This is an important but difficult item to check from the available information. The \$151,000,000 for cofferdams and retaining walls is substantial. Typical sections were assumed for retaining walls constructed under average conditions, and quantities were computed for these sections. Quantities for cofferdams were similarly estimated, using internally braced cofferdams where necessary because of limited space and access for construction. Unit costs were derived on the basis of square-foot cost of sheet piling for a typical cofferdam.

The locations selected as requiring retaining walls where the waterway would be adjacent to railways and other major structures appear correct. Where minor structures would be affected and walls were not provided, it is assumed that the cost of the additional property required had been included in right-of-way costs.

The unit costs used in estimating the costs of retaining walls and cofferdams for this construction are considered reasonable. However, since these costs and the quantities were derived from assumed average conditions and typical sections which may be generally applicable, they probably will vary widely in the several locations. The Hammer Report estimates for retaining walls and cofferdams are accepted with some reservations because

of methods used and the lack of details for checking the more important structures.

Relocation of Utilities

It was stated in the Hammer Report that the details of major relocations of utilities were discussed with owning agencies, and pertinent costs for minor work were based upon similar work on current projects.

From the report there is no way of evaluating the magnitude of the work involved in the relocation of the various utilities; i.e., electric, telephone, gas and product pipelines, water supply, sewers and storm drainage lines, and water intakes and outfalls. There is no indication of the details which were considered in the estimates. In the few cases where length and size of pipeline were given, the costs were found reasonable. The Ohio Edison 138/69/23-kv substation relocation estimate of $920,000 appears low considering the magnitude and complexity of the work involved.

The Hammer Report estimate of relocation costs in the order of $31,240,000 including 15% contingencies was accepted; however, the engineering and supervision costs appear to be low due to the large number of relatively small and varied jobs involved. In the Engineers' opinion these costs would average 10% of the construction costs, thereby making total estimated cost for the utilities category $34,364,000, an increase of $879,000.

Lake Erie Harbor

The estimate for this portion of the work was stated to be based upon the design and costs of comparable work for projects existing and under construction in the Great Lakes area.

Information was provided in the report for estimating dredging quantities. These were checked and found acceptable. It was noted that rock was found in three of nine probings taken

over the area. Also, it was stated that the material to be dredged is not rock, but was believed to be a mixture of sand, gravel, cobbles, and boulders, and that the material was assumed to be hard. The unit cost of $1.00 per cu yd used in the Hammer Report appears low for this material based upon recent bid prices in the area. In the Engineers' opinion this price should be $1.80 per cu yd resulting in an additional cost for the 3,875,000 cu yd involved of $3,100,000.

From the typical sections of the breakwater shown in the Hammer Report, the estimated quantities of rubble seem adequate and the unit prices for this construction appear reasonable.

The estimated cost of Lake Erie port facilities is discussed as a separate subject hereinafter.

Summary and Evaluation of Construction Cost Estimates

The Engineers recognize the wide experience of the Army Engineers in estimating the cost of projects of this nature. Only major items of cost have been reviewed in detail, and costs which could not be checked because of lack of detailed information are accepted where these appear reasonable.

Points of variance with their estimates having material effect on the project cost have been noted in preceding paragraphs. The reliability of some of the estimates, particularly for retaining walls and relocation of utilities, has been questioned.

Both the Hammer Report and the Engineers' estimates are based upon 1964 cost levels. It is the Engineers' opinion that the estimated cost of the following major items should be increased by the indicated amounts.

Estimated Additional Construction Cost of Major Project Items

Item	Estimated Additional Cost
Excavation	$ 74,989,000
Highway and Railroad Bridges, and Relocations	12,171,000
Locks and Dams	16,052,000
Lake Erie Harbor Dredging	3,100,000
Relocation of Utilities	879,000
Total	$107,191,000

Associated costs which are based on a percentage of construction cost (engineering and design, and supervision and administration) would increase the above total correspondingly.

This project is estimated to require a 7-year construction period. If 3 years are allowed to complete hearings and for the design, preparation of plans and specifications, and the taking of bids for construction contracts, the average-cost year, or midpoint of construction period, would be 1971. Based on the Engineering News-Record Cost Index 1958 to 1964, and assuming a straight-line increase to 1971, the 1964 costs would be increased 19% to reach the average cost year level.

The 7-year construction period appears to the Engineers to be a minimum for a project of this size and complexity, requiring the coordination of relocations and other elements of the work with each other and with channel excavation. It should be noted that any increase in this period to a more conservative figure will materially increase the project cost.

Federal First Costs

Federal first costs comprise the construction of the proposed waterway and Summit Reservoir, including engineering,

supervision, overhead, and contingencies related thereto; the alteration or rebuilding of certain common carrier railroad bridges and their approaches in fastland below Warren, Ohio, and all common carrier bridges and their approaches above Warren, e.g., mile 57.5 on the canal; the alteration or reconstruction of all highway bridges and their approaches, and public utility, sewer, water supply, drainage facilities, and the acquisition of rights-of-way north of Warren; the relocation of cemeteries inundated by Summit Reservoir; the extension of the harbor at Fairport, Ohio; and the installation of navigation aids and stream gauging facilities for the waterway. An item for wildlife mitigation facilities is also included. The Hammer Report estimate for this major portion of the costs is $821,864,000.

Allocated costs in the amount of $126,031,000 bring the Federal first costs to a grand total of $947,895,000 not including $629,400 for pre-authorization studies and reports which would ultimately be added. These allocated costs comprise railroad and highway bridges and relocations apportioned in accordance with the Truman-Hobbs Act, as amended, for $85,429,000 and fish, wildlife, and general recreation facilities for $40,602,000.

In addition to Federal first costs of about $948,000,000, interest during the period of construction, as computed in the Hammer Report will amount to $104,000,000, producing a gross Federal investment subject to interest charges of about $1,052,000,000. The salvage value of the federally owned part of the project, estimated to be $9,000,000, will leave a net Federal investment subject to amortization of about $1,043,000,000.

Based on the Engineers' increased estimated costs, as previously discussed, the total Federal first costs would be $1,061,000,000. To this would be added $170,968,000 for interest during the construction period (4-1/4% annual for 3-1/2 years compounded provides an effective interest rate of 16.11%) which would

about $1,232,000,000. Taking into account the same salvage value for reservoir lands leaves a net Federal investment for amortization of $1,223,000,000.

Non-Federal Participation

The Hammer Report, as have earlier reports, includes a stipulation that prior to the start of construction, local interests shall provide assurances satisfactory to the Secretary of the Army that they will:

"a. Provide all lands, easements and rights-of-way, including spoil disposal areas, necessary for the construction and subsequent maintenance of the canal from the mouth of the Beaver River to the beginning of the divide cut north of Warren, Ohio.

b. Hold and save the United States free from damage due to the construction operation and maintenance of the navigation works including, but not limited to those resulting from wave action and changes in ground water.

c. Provide a proportionate share of the cost of bridge alterations over the existing channels of the Beaver and Mahoning Rivers in accordance with the Truman-Hobbs Act as amended from the mouth of the Beaver River to the beginning of the divide cut north of Warren, Ohio.

d. Assume all obligations of owning, maintaining and operating all railway and highway bridges altered or constructed as part of the multi-purpose project with such obligation for each bridge being assumed upon completion of the alteration or construction of that bridge.

e. Provide and maintain, at local expense adequate public terminal and transfer facilities open to all on equal terms with depths in berthing areas and local access channels serving the navigation channel, commensurate with the depths provided in related project areas.

f. Accomplish all utility relocations and alterations from the mouth of the Beaver River to the beginning of the divide cut north of Warren, Ohio.

g. Provide assurances that they will not withdraw water for consumptive use or divert water around the locks and dams from the water supply provided by the project works.

"h. Contribute in cash for recreation and fish and wildlife enhancement measures, 2.264 per cent of the total first cost of the project, such amount currently estimated at $23,203,000 to be paid in installments prior to commencement of pertinent items in accordance with construction schedules as required by the Chief of Engineers or to be paid over the life of the project in accordance with principles established by the Water Supply Act of 1958 as amended."

As stated in the Hammer Report:

"Local interests have not been requested to furnish the necessary assurances of local cooperation for the items specified above. Agreements to provide such assurances would require a review of the general plan of this report and therefore have been deferred until such time as the report is made available for general distribution."

The "local interests" that would be required to underwrite the estimated non-Federal first cost definable investment of $77,000,000 or 7-1/2% of the first cost investment excluding Fairport Harbor and user terminal facilities investment, have not been defined in the Hammer Report. It has been assumed that rights-of-way and disposal areas would be a public responsibility, but the responsibility for alteration or reconstruction of facilities of many ownerships both public and private is indeterminable.

Certain other costs to be underwritten by local interests have not been estimated and alone could well exceed the $77,000,000 figure. For example, item (b) above concerns liabilities associated with construction, operation, and maintenance of

the waterway including wave action from forecast 4- to almost 8-ft waves. Also item (g) above concerning nonwithdrawal of water from the project works for consumptive use would cause the State of Ohio to seek an alternate to its planned water supply reservoir at the summit site.

The estimated non-Federal first cost investment of $77,000,000 is intended to cover all rights-of-way and disposal areas south of Warren, Ohio, e.g. the first 57.5 miles of the proposed canal, and the alteration or reconstruction of steel company bridges, water intakes and outfalls, and public utility, sewer, water supply, and drainage facilities. The allocated portions of the cost of alteration or reconstruction of certain highway and common carrier railroad bridges and approaches apportioned under the Truman-Hobbs Act, and the fish, wildlife, and general recreation facilities are also included.

In addition to the definable non-Federal first costs of $77,000,000, interest during the construction period as computed in the Hammer Report will amount to $8,000,000, producing a gross investment subject to interest charges and amortization of $85,000,000, excluding Fairport Harbor terminal facilities of an estimated $96,311,000 and expected user terminal facilities of an estimated $26,235,000, which are discussed hereinafter. The grand total non-Federal investment would then be approximately $208,000,000.

Based on the Engineers increased estimated costs, as previously discussed, the total non-Federal first costs would be $79,500,000, which with interest during the construction period of $11,500,000 (3-1/8% and 4-3/4% annual for 3-1/2 years compounded for an effective interest rate of 11.60% and 18.175% for public and private financing, respectively) would produce a gross non-Federal investment of $91,000,000 subject to interest charges and amortization. Including the Fairport Harbor and expected

user terminal facilities as above brings the Engineers' estimated non-Federal investment to approximately $214,000,000.

The division of these non-Federal first costs estimates between Pennsylvania and Ohio is shown on Exhibit No. 2.

Types and Costs of Floating Equipment

The proposed dual locks with usable chamber space of 84 x 720 ft would be compatible with navigation equipment and tow formations on the Allegheny and Monongahela Rivers and, for Ohio River-type tow formations by regrouping. While larger 110 x 1,200 ft locks enable single towboats to handle up to 22 standard barges on the Ohio River, such tows would not be practicable on the narrower channel and more frequent lockages on the proposed canal.

For the greater bulk of canal traffic the following types of navigational units would be satisfactory:

(a) A 1,500- or 2,000-hp towboat with 11 open barges, each 26 x 175 ft

(b) A 2,000-hp towboat with six weathertight covered "jumbo" size barges, each 35 x 195 ft

(c) A 2,000-hp towboat with six watertight, covered "jumbo" size barges, each 35 x 195 ft for river and canal use and 1,500-hp towboat for lake use.

Other specialized barges for bulk liquid cargoes would also be required.

The towboat horsepowers above permit maximum towing speeds for faster transit time than those used in the past.

Quotations from shipyards indicate that on a current price basis a fully equipped 2,000-hp towboat, 120 x 27 x 7 ft draft would cost $570,000, and a 1,500-hp towboat, similar dimensions, would cost $410,000 or $30,000 and $115,000 less than estimated in the Hammer Report.

Present coal loading and unloading equipment is designed for the standard 26 x 175 ft open barge; therefore, units of these dimensions could be used interchangeably with existing equipment throughout the inland waterways. "Jumbo" barges because of greater size, 35 x 195 ft, have the requisite larger capacity to warrant their use, but would require extensive alterations to existing cargo transfer facilities, the costs of which have not been estimated. Such "jumbo" barges crossing Summit Reservoir would require weathertight hatch covers and for Lake Erie service would require watertight hatches due to wave action encountered.

Quotations from shipyards indicate that at current prices, such barges would cost the following amounts which are essentially the same as estimated in the Hammer Report:

(a) Coal barge, standard Pittsburgh type, double raked, 26 x 175 x 9 ft draft, capacity 1,000 short tons, open hopper, river type, average $46,000

(b) Ore barge, "jumbo" size, standard river, covered, weathertight, semi-integrated, 35 x 195 x 9 ft draft, capacity 1,450 tons, average $83,000

(c) Ore barge, "jumbo" size, watertight hatches, capable of unrestricted lake movement by hawser tow, also by canal and river towboat operation, semi-integrated, 35 x 195 x 9 ft draft, capacity 1,350 tons, average $120,000.

Based on the above, the Hammer Report prices for oil barges, 52 x 290 ft and chemical barges, 52 x 195 ft were deemed satisfactory by the Engineers.

To assure a minimum of towboat delay while barges are loaded, or discharged, barge operators follow the general practice of having the same number of barges loading and the same number discharging as are moving plus spares. The Hammer Report uses this basis without spare barges for general bulk cargo service, but in the petroleum and chemical service only the moving units were con-

sidered. The following tabulation shows the increased navigational unit first costs based on the Engineers' estimated prices and recommended inland waterway practice.

Comparison of Navigational Unit First Costs

Navigational Unit	Hammer Report No.	Hammer Report Amount	Engineers No.	Engineers Amount	Increase (Decrease)
Open Hopper, 26x175'	33	$1,485,000	34	$1,564,000	$ 79,000
1,500-hp Towboat	1	525,000	1	410,000	(115,000)
Total 1,500-hp Unit		$2,010,000		$1,974,000	$ (36,000)
With 2,000-hp Towboat	1	600,000	1	570,000	(30,000)
Total 2,000-hp Unit		$2,085,000		$2,134,000	$ 49,000
Covered Hopper, 35x195'	24	$2,040,000	25	$2,075,000	$ 35,000
2,000-hp Towboat	1	600,000	1	570,000	(30,000)
Total 2,000-hp Unit		$2,640,000		$2,645,000	$ 5,000
Covered Watertight, 35x195'	24	$2,880,000	31	$3,720,000	$ 840,000
2,000-hp Canal Towboat	1	600,000	1	570,000	(30,000)
1,500-hp Lake Towboat	0	-	1	410,000	410,000
Total		$3,480,000		$4,700,000	$1,220,000
Oil Barge, 52x290'	2	$ 550,000	7	$1,925,000	$1,375,000
2,000-hp Towboat	1	600,000	1	570,000	(30,000)
Total		$1,150,000		$2,495,000	$1,345,000
Chemical Barge, 52x195'	3	$1,050,000	10	$3,500,000	$2,450,000
2,000-hp Towboat	1	600,000	1	570,000	(30,000)
Total		$1,650,000		$4,070,000	$2,420,000

The conventional 26 x 175 ft barge will hold 1,000 tons when loaded to a 9-ft draft. When used on waterways with a controlling depth at 9 ft, barge load is held to 900 tons. Thus an 11-barge tow would carry 9,900 tons.

The "jumbo" river and canal 35 x 195 ft barge has a capacity of 1,480 tons when loaded to a 9-ft draft, but a controlling depth of 9 ft reduces the capacity to approximately 1,380 tons, making the tow 8,280 tons (6 barges).

Similarly the river, canal, and lake barge will drop in capacity from 1,390 tons to approximately 1,290 tons, making the tow 7,740 tons for the river, canal, lake portion (6 barges) and 2,580 tons for a lake tow (2 barges).

The reduced capacity for a controlling depth of 9 ft was not followed in all cases in the Hammer Report.

The Engineers concur that it is not practical to consider the use of Great Lakes cargo vessels in the proposed canal due to the tremendous increase in project costs that would be necessary to accommodate these ships.

<u>Costs of Canal Operation</u>

Costs of proposed canal operation will consist of the Federal and non-Federal annual fixed and direct costs resulting from the waterway construction and operation. Navigational operating costs, lake terminal charges, and transfer costs at destination are associated with and will appear as water transportation rates; however, sufficient moneys must be available to cover the financing of such operations.

A 3-1/8% rate of interest has been used in the Hammer Report for the financing of both Federal and non-Federal first cost investments. This interest rate, while reasonable for public non-Federal debt, appears unrealistic for the balance of the debt considering the current cost of Federal borrowing and the private industry financing required. The Engineers considered interest rates current in May 1965 for normal financing through 20-30 year bonds as the basis in arriving at a rate of 4-1/4% for Federal funds, 4-3/4% for private funds, and 3-1/8% for non-Federal public borrowing. For full 50-year life of project financing, these rates would be expected to be a few points higher; however refinancing at approximately the mid-term could be effective.

Annual Fixed and Direct Costs of Canal Operation

Fixed and direct costs of proposed canal operation will consist of the annual debt service charges on the Federal and non-Federal construction, maintenance and operating expenses, and adjustments for loss of productivity of land, as shown in the table below:

Proposed Project Fixed and Direct Cost Estimates

	Hammer Report	Engineers' Estimate
Federal Construction	$51,800,000	$69,060,000
Non-Federal Construction	4,000,000	4,790,000
Subtotal	$55,800,000	$73,850,000
Less Estimated Annual Credits "recognizing present worth of future recreational facilities"*	1,600,000	1,600,000
Total Annual Charges	$54,200,000	$72,250,000

The comparisons of these annual costs, in detail, are shown on Exhibit No. 3.

Navigational Operating Costs

The Engineers studied and analyzed the navigational operating costs for the proposed waterway system and developed rates for Trades 1, 2, and 3 which represent the major tonnages to be moved. Exhibits Nos. 4 and 5 show these computations in detail similar to that used in the Appendix IX of the Hammer Report. A summary and comparison of the salient points is tabulated below:

* See p. 99, Vol. I, Hammer Report

Summary of Navigational Operating Costs

	Hammer Report	Engineers' Estimate
Trade 1		
1,500-hp Towboat		
Total Trip Time	68.7 hours	86.0 hours
Trips/Month (700 hr)	10.18	8.14
Tons/Month	104,700	80,586
Ton-Miles/Month (millions)	15.23	11.68
Investment	$2,010,000	$1,974,000
Cost/Month	$54,240	$52,375
Revenue/Month	$75,140	$72,938
Cost/Ton-Mile	3.56 mills	4.48 mills
Rate/Ton-Mile	4.94 mills	6.24 mills
Rate/Ton	$0.718	$0.905
2,000-hp Towboat		
Total Trip Time	65.7 hours	81.5 hours
Trips/Month (700 hr)	10.65	8.59
Tons/Month	109,500	85,041
Ton-Miles/Month (millions)	15.23	12.33
Investment	$2,085,000	$2,134,000
Cost/Month	$57,240	$56,903
Revenue/Month	$78,990	$79,132
Cost/Ton-Mile	3.61 mills	4.62 mills
Rate/Ton-Mile	4.97 mills	6.42 mills
Rate/Ton	$0.721	$0.931
Trade 2		
Loaded North and South		
Total Running Time	92.3 hours	116.2 hours
Trips/Month (700 hr)	7.58	6.02
Tons/Month	132,000	99,691
Ton-Miles/Month (millions)	27.5	20.74
Investment	$2,640,000	$2,645,000
Cost/Month	$61,100	$60,009
Revenue/Month	$88,600	$87,561
Cost/Ton-Mile	3.22 mills*	2.89 mills
Rate/Ton-Mile	3.22 mills	4.22 mills
Rate/Ton	$0.671	$0.878

* Computes as 2.22 mills

	Hammer Report	Engineers' Estimate
Loaded North and 1/3 South		
Total Running Time	88.2 hours	111.5 hours
Trips/Month (700 hr)	7.94	6.28
Tons/Month	92,000	66,460
Ton-Miles/Month (millions)	19.15	13.83
Investment	$2,640,000	$2,645,000
Cost/Month	$61,100	$60,009
Revenue/Month	$88,600	$87,561
Cost/Ton-Mile	3.20 mills	4.34 mills
Rate/Ton-Mile	4.63 mills	6.33 mills
Rate/Ton	$0.952	$1.317
Trade 3		
River and Canal Phase		
Total Running Time	92.3 hours	116.2 hours
Trips/Month (700 hr)	7.58	6.02
Tons/Month	123,000	93,190
Ton-Miles/Month (millions)	25.6	19.38
Investment:		
Total	$3,480,000	$3,570,000
8/12 of Year	$2,320,000	$2,380,000
Cost/Month	$68,280	$67,059
Revenue/Month	$104,480	$104,247
Cost/Ton-Mile	2.67 mills	3.46 mills
Rate/Ton-Mile	4.19 mills	5.38 mills
Rate/Ton	$0.850	$1.119
Lake Phase		
Total Running Time	30.8 hours	30.7 hours
Trips/Month (700 hr)	22.75	22.80
Tons/Month	61,500	58,824
Ton-Miles/Month (millions)	6.15	5.88
Investment:		
Total	$1,270,000	$1,130,000
8/12 of Year	$847,000	$753,000
Cost/Month	$45,120	$43,417
Revenue/Month	$58,220	$55,184
Cost/Ton-Mile	7.34 mills	7.38 mills
Rate/Ton-Mile	9.47 mills	9.39 mills
Rate/Ton	$0.947	$0.938
Combined Coal Rate/Ton	$1.797	$2.057
Combined Coal Rate/Ton-Mile	5.84 mills	6.68 mills
Ore Rate/Ton	$0.85	$1.119
Ore Rate/Ton-Mile	4.09 mills	5.38 mills

The Engineers' estimated water transportation rates are higher in almost all cases than those in the Hammer Report. The increase reflects for the most part somewhat reduced towing speeds for the waterway based on information received from several operating towing companies on the Ohio River. The Cincinnati Division Engineers' review of the Hammer Report also stated that towing speeds should be reduced as much as 40%, thereby adversely affecting transportation savings.

Lake Terminal Charges

The lake terminal charges would be based upon the cargo handling facilities required to pass the proposed canal traffic. The necessary facilities to handle the forecast traffic would consist of piers, mooring cells, materials handling equipment, and harbor tugs which the Engineers estimate would require an investment of $96,310,717 to provide. The estimated cost of these facilities, allocated to iron ore and coal-handling functions is shown on Exhibit No. 6. Public financing of this investment and the operation thereof by the Port of Fairport or similar public authority has been assumed.

Annual operating costs by type of cargo have also been estimated and combined with debt service requirements to derive the following cargo transfer rates:

	Per Ton
Iron Ore:	
1. Unloading lake vessels to barges or storage	$0.16095
2. Loading barges from storage	.15829
3. Combined rate for passage through port	$0.31924
Coal:	
1. Unloading barges to storage	$0.13193
2. Loading lake vessels from storage	.12443
3. Combined rate for transshipment	$0.25636

These estimated rates reflect the annual debt service requirements, reserve for replacements, cost of storage, and operating labor, maintenance, power, and administrative expenses; and are based upon a potential annual tonnage of 32,000,000 for each type of operation. Detail makeup of each rate is shown on Exhibit No. 7. Should actual tonnage use be less than 32,000,000 tons design capacity, the resulting rates would have to be adjusted upward accordingly.

The handling of coal reflects a higher rate than present coal dumping charges due to the lower cost of dumping coal on a railroad car basis rather than unloading by bucket lift.

Transfer Costs at Destination

The Hammer Report assumed that potential users of the canal would install at their own expense equipment for unloading barges and subsequent intraplant transfers of the iron ore, limestone, or coal. While individual mills would not require as much bulk-handling equipment as would the Lake Erie terminus, it is improbable that they could attain the same degree of machine utilization, and in most instances the additional intraplant conveying equipment required will be extensive.

An investigation was made to determine costs of unloading ore, coal, and limestone requirements from barges at steel mills located along the proposed canal.

The basic elements required for such facilities are:

1. Wharves and dockage
2. Barge unloading system
3. Conveyor transfer and stacker to existing stockpiles currently supplied by railroad transport.

For this purpose the following assumptions were made:

1. Barges are 35 x 195 ft with 1,480-ton capacity

2. Unloading system capable of handling 1,000 tons per hour for 2 shifts of 7-1/2 hours or a total of 15,000 tons per working day of 2 shifts, with 1 shift used for maintenance and repairs. This operation, working 200 days per year will handle 3,000,000 tons annually consisting of:

   a. 1,725,000 tons iron ore
   b. 985,000 tons coal
   c. 290,000 tons limestone

   No allowance is made for bulking variations of these materials.

3. The plant layouts are such as to provide adequate berthing room without interference with canal traffic and existing railroad trackage.

Facilities

It is assumed that barges will be towed to plant site in tows of 6 barges, 3 abreast. The required length of wharf should allow for a tie-up of 3 groups of 3 barges abreast, room for 5 barges in process of being unloaded, and a reassembly area to make up a return tow 2 barges long, with a 300-ft-long allowance for maneuvering, or a total length of 2,300 ft. This wharf would be constructed of steel sheet piling acting as a bulkhead, tied back by means of concrete anchors and steel tie-rods. To permit 3 barges abreast without interfering with the canal traffic, an area 100 ft wide, 2,300 ft long is provided by dredging and excavation for a mooring depth of 14 ft. Fenders and mooring devices are provided.

Five mooring cells are required for tieing up barges in various stages of use. These consist of steel sheet piles driven in a 16-ft diameter circular form, filled with sand, topped with concrete slabs and furnished with necessary timber fenders and hardware.

Estimated costs of above are:

2,300 ft Wharf	$1,199,870
5 Mooring Cells	50,130
Direct Cost - Wharfage & Dockage	$1,250,000

The unloading system is assumed to consist of a traveling tower and conveyor, capable of handling 1,000 tons per hour. The tower is made up of a structural steel frame riding on powered double flange wheels rolling on crane rails the length of the wharf. This frame carries a horizontal craneway extending over barges being unloaded, and supports the traveling clamshell bucket, with 1,000-ton hourly capacity, which after picking up its load, moves back and dumps it into a steel hopper mounted on the frame. From the hopper, the material is dropped into an apron feeder, similarly mounted, which deposits it onto conveyors running parallel to the crane-way.

The conveyor system parallel to the crane-way feeds the unloaded material to other conveyors which carry it to the plant iron ore, coal, or limestone stockpile areas currently supplied by railroad cars. In this area the material is distributed to the proper piles by means of a traveling "stacker" equipped with a conveyor mounted on a movable, swinging boom.

From this point, the materials are recovered for mill use by means of existing installations.

Estimated costs of above are:

Unloading Tower	$1,000,000	
Conveyors and Stacker	500,000	
Direct Cost of Unloading System	$1,500,000	
Direct Cost of Wharf, Dockage, and Unloading System		$2,750,000
Engineering & Supervision		165,000
Total Cost for each Installation		$2,915,000

Determination of Plant Cost per Ton Handled

Life of this installation, from "Depreciation Guidelines and Rules", Revenue Procedure 62-21, U.S. Treasury Dept., Publication No. 456, rev. Aug. 1964, is 20 years (for Coal and Ore Wharves).

Annual depreciation on straight-line basis is $145,750.

If the annual output at full operating efficiency is 3,000,000 tons, the depreciation cost will be $0.0486 per ton.

The plant will operate on a two-shift basis with one shift for maintenance and repairs and will require the following operating crew:

1	General Unloading Superintendent
2	Unloading Foremen
2	Crane-unloading Operators
2	Crane-unloading Oilers
2	Signalmen
2	Hopper, Apron Feed Operators
2	Conveyor Operators
2	Stacker Operators
4	Barge Shift Engine Operators (2 per shift)
8	Barge Shift Cable Handlers (4 per shift)
3	Maintenance Men (mechanics)
3	Electricians (light and power)
1	Storekeeper
34	Men @ 8 hr. @ $5 average/hour or $1,360/24 hours.

For 15,000 tons daily, operating cost is $0.0907/ton.

Estimated cost of maintenance materials: $0.0024/ton, based on equipment cost.

Power cost is taken at 10% of labor or $0.0091/ton.

Overhead and carrying charges based on 32% of all of above amounts to $0.0483/ton.

Summary of Costs per Ton Unloaded

Depreciation	\$0.0486
Operation	0.0907
Maint. Materials	0.0024
Power & Fuel	0.0091
Subtotal	0.1508
Overhead and Carrying Charges	0.0483
Total Estimated Cost of Barge Unloading at Mill, Based on 100% Efficient Use of 3,000,000-ton Annual Capacity Facility	\$0.1991/ton

The above rate is considered representative of average conditions but would be materially increased for design capacities at or below 1,000,000 tons annually.

TRAFFIC

Potential Traffic

Traffic on the proposed canal will consist mainly of the bulk dry raw materials used by the steel mill blast furnaces in the Pittsburgh-Youngstown area and south on the Ohio River as far as the Ashland, Kentucky, area. These materials are iron ore, either raw or pelletized, coking coal, and limestone. Coal for thermal power stations could use the canal to reach Lake Erie where it can be delivered directly to nearby ports or transferred to lake vessels for delivery to more distant ports. The dry bulk commodities would constitute from 90% to 95% of the canal traffic, with chemicals, finished steel products, building materials, and miscellaneous items making up the balance. To attract this traffic the canal must compete with a well-established network of railroads and truck lines presently handling this tonnage and capable of serving the needs of these industries as they expand in future years.

Success in diverting this tonnage will depend on the difference between the barge rates and railroad rates in effect when the canal is in operation. The railroads will certainly reduce rates on these commodities by establishing unit train operations and other practices to improve equipment utilization and reduce costs. This has already been done in several areas of the country when railroad freight tonnage has been threatened by other forms of transportation or economic measures. Exhibit No. 8 shows a curve plotted from representative unit train rates now being offered. The rates are based on railroad-owned cars and conditions shown in Exhibit No. 9, Unit Train Tariffs on Coal. These rates are subject to special conditions which limit loading and unloading times and assign detention charges to be paid if

these times are exceeded. Cars are not weighed in transit unless requested and a fee paid. Shippers or consignees weights are accepted. An adjustment of 1 mill per ton-mile was made in certain rates to compensate for shipper-owned cars for developing the curve in Exhibit No. 8.

To compare barge rates and unit train rates it is necessary to add to each the handling costs at the origin and destination. The use of barges for delivering iron ore directly to the steel mills will require the provision of unloading facilities at each location. These facilities will vary in complexity and cost depending on dock space available, distance from the dock to the storage area, and the location and condition of present facilities for unloading iron ore from railroad cars.

In order for a steel mill to justify construction of barge unloading facilities, the cost differential between rail and water movement must be sufficient to provide a satisfactory return on the investment in these facilities. The Engineers estimate that a differential of 29.2 cents per ton would be necessary to provide such a return. However, the individual steel companies will have varying conditions and costs to consider, as well as the competition for capital from other projects within the organization. As a result some potential users of the canal may not provide traffic in the early years of the canal operation and some may never go to barge transportation.

Estimates of requirements for iron ore, coal, and limestone for the steel mills in the area are based on a projection of the pig iron production in the Ohio-Pennsylvania region during the period 1910-1963, and applying use factors for each of the materials, recognizing technological changes tending to reduce quantities of coke and limestone needed as the use of beneficiated ore increases.

Pennsylvania

Aliquippa	Jones & Laughlin Steel
Braddock	United States Steel
Clairton	" " "
Duquesne	" " "
McKeesport	" " "
Midland	Crucible Steel
Monessen	Pittsburgh Steel
Neville Island	Pittsburgh Coke & Chemical
Pittsburgh	Jones & Laughlin Steel
Rankin	United States Steel

West Virginia

Benwood	Wheeling Steel
Weirton	Weirton Steel

Kentucky

Ashland	Armco Steel

Exhibit No. 10 shows the estimated average annual iron ore requirememts for these mills in the year 1975. The total requirement amounts to 39,602,000 net tons. Based on iron ore sources reported in 1960, these mills will receive about 33% or 13,013,000 net tons from foreign sources other than Canada. This foreign ore is now received by rail from East Coast ports. The remaining 67% or 26,589,000 net tons, including most of the Canadian imports, may be considered to be received at lake ports for transshipment by canal or rail to the blast furnaces. Some Canadian ore is received at East Coast ports and transshipped by rail to the Pittsburgh area.

There are three mills in the area whose iron ore requirements are not considered to be potential canal traffic because of their distance from the canal. The locations are:

Hubbard, Ohio	Youngstown Sheet & Tube
Farrell, Pa.	Sharon Steel
Sharpsville, Pa.	Shenango Furnace

The United States Steel Corporation has a beneficiating plant at Saxonburg, Pa., north of Pittsburgh and not accessible by water. This plant processes foreign ore, including some Canadian ore, and a small quantity of lake ore. This ore which is shipped from the East Coast or Lake Erie by rail is also excluded as potential canal traffic. The total iron ore tonnage considered to be potential canal traffic is estimated to be 24,664,000 net tons for the year 1975.

Coal

Coal sources for the steel mills in this area are located to the south and east and, except for coking plants in the Youngstown area, do not provide potential canal traffic. Exhibit No. 10 shows estimated coking coal requirements for the plants for the year 1975 and the potential canal tonnage for the mills which are in the Youngstown area totaling 5,421,000 net tons.

In the year 1964 there was a total of 45,232,130 tons of coal delivered to Lake Erie and Lake Ontario ports by railroad for transshipment in lake vessels to thermal power stations, coking plants, and other users along the shores of the Great Lakes. An additional 457,754 tons was delivered as fuel for Lake vessels for a grand total of 45,689,884 tons.

Projections of coal requirements in the Great Lakes area including Canada, as contained in Appendix IV of the Hammer Report, were studied and found to be acceptable as a basis for estimating potential benefits to be derived from canal utilization for movement of coal from various sources in the Appalachian coal-producing districts to lower lake ports for transshipment to users in the lake states and Canadian provinces on the Great Lakes.

The Hammer Report evaluation of the competitive influence of nuclear power in the years 1975 to 2025 is consistent with the National Power Survey prepared by the Federal Power

Commission and published in 1964. Development of mine-mouth generation and high-voltage transmission of electric power to consuming centers will also tend to reduce the movement of coal as indicated in the evaluation. These two influences will continue to put pressure on rail rates as their development continues.

Due to the availability of water transportation along the Ohio and Monongahela Rivers, the coal reserves along the rivers have been exploited heavily, leaving a larger percentage of the remaining deposits farther from the rivers. The trend in the future will be toward more coal production back away from the rivers and less along the rivers as the water-located deposits are depleted. The Engineers have not studied extensively to what extent this trend will favor all rail haul for future years or to what extent it consists of metallurgical coal which is most susceptible to canal competition.

Limestone

Limestone requirements for the steel mills were evaluated by the Engineers and the estimated quantity representing potential canal traffic in the year 1975 was very close to that estimated in the Hammer Report. However, for subsequent years the rate of increase estimated by the Engineers was lower, reflecting the anticipated migration of the industry toward centers of steel consumption. A comparison of the quantities at 10-year intervals follows.

	Hammer Report	Engineers' Estimate
	(Short Tons)	
1975	4,760,750	4,893,000
1985	5,332,040	5,206,000
1995	5,998,545	5,539,000
2005	6,665,050	5,893,000
2015	7,236,340	6,270,000
2025	7,569,593	6,671,000

Steel Mill Products and Other Traffic

Other potential traffic for the canal as set forth in the Hammer Report amounts to less than 10% of the total tonnage and was accepted by the Engineers as reasonable for purposes of estimating potential benefits.

Transportation Rates

The Engineers analyzed the rates for train-load movements as presented in Table No. 5, Appendix IX of the Hammer Report, and additional train-load rates furnished by the major railroads in the area, and find that these train-load curves generally fall in two categories. The curve labeled "Projected Railroad Rates Without Canal" in the Hammer Report and referred to as Curve A, does generally reflect present train-load rates in areas where waterborne transportation is not a competitive factor. In the Hammer Report these rates were used as a base for calculating future transportation savings. It must be realized, however, that the use of train-load rates and unit-train operations is comparatively new and does not yet reflect the known technological improvements such as integral trains and the effects of recent labor agreements on the railroads which could continue to reduce railroad transportation costs. The same competitive factors which have sparked the development of unit-train rates in areas not competitive with water transportation, such as movement of solids by pipeline, alternate forms of energy for power generation, and mine-mouth burning of coal, can be expected to continue.

The curve labeled "Projected Rail Rates with Canal" in the Hammer Report and referred to as Curve B generally reflects water competitive rates presently in effect, and the Engineers agree that in case the canal were constructed the railroads, to remain competitive, could be expected to offer rates at least this low. The same comment regarding known technological improvements

concerning noncompetitive rail rates would apply likewise to the rates outlined on Curve B. The Hammer Report discounted the effect of technological improvements in rail transportation costs as well as in barge transportation costs on the basis that the same difference in rates would be maintained as these improvements took place in both modes. Considerable improvement in rail transportation costs can still be made through larger equipment and faster means of loading and unloading, providing better equipment utilization, without extensive right-of-way improvements. In the proposed canal, however, the speeds and tow sizes are somewhat limited by the canal size and the Engineers do not believe that there is the same short-range potential improvement that exists on the rail.

On Exhibit No. 11 the Engineers have plotted Curves A, B, and C from Appendix IX, Exhibit I, of the Hammer Report and have given them the same designations. Two additional curves are shown on Exhibit No. 11 designated as Equivalent Barge Rates Curve D and Adjusted Barge Rates Curve E. Curve D was developed by subtracting from the rates in Curve B, a figure which represents the estimated cost per ton-mile for installation and operation of required barge unloading facilities at the steel mills. In the Engineers' opinion, Curve D represents the barge rates that would cause a diversion from rail to barge, assuming that rail rates were not reduced below those represented by Curve B. A comparison of the rates in Curve A, Curve B, the unloading cost, and Curve D, is outlined below:

Miles	Rates (mills per ton-mile) Curve "A"	Curve "B"	Unloading Cost	Curve "D"
50	17.6	12.6	5.8	6.8
75	16.1	11.1	3.9	7.2
100	15.1	10.0	2.9	7.1
125	14.2	9.2	2.3	6.9
150	13.4	8.5	1.9	6.6
175	12.6	7.8	1.7	6.1
300	9.2	5.4	1.0	4.4
400	7.6	4.3	.7	3.6

The unloading cost in the table above includes operating cost, plus a return on the investment for a total of 29.2¢ per ton. It was assumed that investment in new barge unloading facilities would have to compete with other investments for the capital available to the steel companies, and includes a comparable return. It will be noted that as the mileage decreases, the barge unloading cost per ton-mile (the horizontal difference between Curve B and Curve D) increases. This curve indicates that barging may be uneconomical at distances of approximately 50 miles or less due to barge unloading costs.

The Engineers have plotted Curve E on Exhibit No. 11 labeled "Adjusted Projected Barge Rates" reflecting their independent analysis of expected barge rates as outlined elsewhere in this report. The Engineers' estimates of barge operating costs are approximately 31% higher than those estimated in the Hammer Report and plotted as Curve C, Projected Barge Rates.

Probable Waterway Traffic

The total potential traffic for the proposed canal, as shown on Exhibit No. 12, may not be reached and in any event traffic will build up over a period of years as terminal facility additions or replacements are economically justified.

Iron Ore Traffic

Once the Lake Erie-Ohio River Canal is a reality, the railroads and the barge companies will be free to compete for the total potential iron ore tonnages moving from the lower lake ports to the Youngstown, Pittsburgh, and Ohio River steel mills. The Engineers believe that under these circumstances, railroad rates could be expected to approach barge competitive levels as shown on Exhibit No. 11, Curve B. The majority of the steel mills in the Youngstown-Warren area are located adjacent to the proposed canal location, separated from it for most of the distance on both sides by multiple-track railroad lines and railroad yards. Very little, if any, additional property is available for the construction of coal or iron ore unloading and storage facilities adjacent to the canal and close to the mills. It is quite obvious from on-the-ground inspection of this area that such facilities would be much more expensive than the average cost reflected by the curve of equivalent barge rates shown on Exhibit No. 11 due to the absence of available property on which to construct these facilities. The effect of the increased unloading costs in this area would be to reduce the potential savings, particularly in the low mileage range, and for this reason the Engineers doubt if the bulk of the Youngstown ore would ever be diverted to barge transportation. There appears to be very little backhaul available for the ore barges which would increase barging costs on this shorthaul.

The Jones & Laughlin Steel Corporation at its Pittsburgh plant requires daily delivery of ore at the present time due to lack of storage space, and for this reason the Engineers believe that at this plant the excessive cost of providing barge deliveries of ore would prohibit diversion of ore for this plant to canal transportation. It is quite likely, however, that its Aliquippa plant might be able to take advantage of the lower canal rates.

The U.S. Steel Corporation at its Pittsburgh plants receives a large percentage of its iron ore from its Saxonburg sintering plant. However, the ore coming from this plant is predominantly foreign ore, moving from the Eastern Seaboard by rail and blended with small amounts of raw lake ore. Since Saxonburg is not accessible to water, the ore coming to this plant could be expected to continue. However, as the raw ore deposits in the upper lakes region are exhausted, the pelletized ore which is taking its place could profitably be moved via the canal in competition with rail rates to the U.S. Steel Pittsburgh plants with the installation of ore unloading facilities.

On the other hand the Hammer Report pointed out that on the basis of railroad incremental costs, no iron ore or coal would be expected to move via the proposed Canal. However, the Engineers believe that the railroads faced with waterway competition could only be expected to reduce rates sufficiently to maximize profits and retain part of the traffic they now enjoy, so that the Bessemer & Lake Erie Railroad would be expected to retain perhaps 50% of the iron ore being handled between the lower lake ports and the Pittsburgh area.

The Wheeling Steel Company and the Weirton Steel Company, located on the Ohio River, might likely turn to water transportation for their iron ore. However, in the Engineers' opinion, steel companies whose annual iron ore and limestone requirements do not exceed a million tons would find it hard to justify the additional investment and handling costs involved in barge unloading of ore. The cost of unloading facilities for mills whose raw material tonnage is about 1,000,000 tons per year would add almost twice as much to the barge rate as the larger facilities capable of handling 3,000,000 tons per year as previously described. The Engineers have assumed that the steel mills involved would have

to retain their rail unloading facilities even if new barge unloading facilities are built on the basis that foreign ore will continue to come in via rail from East Coast ports.

While it is claimed in the Hammer Report that the proposed canal will operate the year-round, steel companies will be slow to make the investments in facilities required until others have demonstrated that this is so. Also, individual steel companies will be slow to enter into these long-term investments in fixed facilities until the railroad rate reductions due to waterway competition have somewhat stabilized, for fear competitors may realize additional savings via rail without the required investment.

As a result of the foregoing considerations the Engineers estimate that about 56% of the potential ore traffic will be diverted to the canal over a period of 10 years and expected savings will show similar increases.

<u>Coal and Coke Traffic</u>

Youngstown-Warren steel mills are not equipped with facilities for unloading coal from barges. However, it is possible that coal rates via the proposed canal to the extent they reflect a return of empty equipment used in the iron ore and limestone trade and particularly those of unregulated carriers, will probably be low enough to attract some traffic. In most instances, however, the volumes of coal involved are too low to justify the necessary investment in facilities and it is questionable whether any one, except Youngstown Sheet and Tube, Campbell Works, would be able to take advantage of the lower coal rates. Utility coal, however, from Ohio River origins for transshipment at lower lake ports will probably move via the waterway to the extent that it is handled in the return barges from the iron ore and limestone traffic. Coking coal traffic diversion is expected to one steel

mill representing about 47% of the potential traffic. The utility coal traffic that may be diverted to the canal varies between 43% and 58% of total potential. As pointed out earlier in the report, however, the depletion of reserves adjacent to the rivers would tend to favor all-rail handling of coal in future years.

Limestone Traffic

The estimated total potential limestone tonnage projected in the Hammer Report appears reasonable and the Engineers expect that approximately the same economic competitive factors would apply to this traffic as to the iron ore traffic. Approximately 71% of the potential limestone traffic is expected to be diverted to the canal.

Steel Mill Products and Other Materials

Canal traffic in steel mill products and other materials including a rapidly increasing volume of chemicals and related products is expected to materialize at a lower rate than estimated in the Hammer Report. Current large investments being made in new railroad cars for handling chemicals and petroleum products, tariff reductions, and car allowance increases for large volumes by the railroads would tend to delay and reduce the diversion to water transportation.

The Engineers estimate that about 50% of the potential traffic in steel mill products and other materials will be diverted to the canal.

Probable Navigation Benefits

In addition to savings to be realized from conversion to canal transportation for iron ore and coal, these raw materials will also benefit from tariff reductions on the railroads as rates are reduced to meet canal competition. This reduction from present rates is expected to be about 30 cents per ton. Summarizing benefits to be gained from canal transportation and rail rate

reductions, the Engineers believe that the average probable navigation benefits for the first 10 years of the canal operation will be about $17,800,000 per year and in succeeding years will be about $50,600,000 per year. The average for the 50-year life of the project will be about $44,070,000 per year.

OTHER CONSIDERATIONS

Recreation

The Bureau of Outdoor Recreation and the Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, each submitted a report to the Army Engineers in which they outlined their requirements of recreation facilities. The Summit Reservoir, located in the State of Ohio, is the only area considered for recreational development in the project. They have assumed that the proposed project would have an area of influence within a 100-mile radius of Summit Reservoir. The reported population within this area for 1960 was 7.8 million.

These reports, in Appendix V of the Hammer Report, contend that there is an existing inadequacy of recreation facilities and supplies to meet the demand within the area, and even with recreation developments that are in prospect it is estimated that by 1975 there will still be a deficit of 10.7 million annual recreation days which will increase to 20.2 million in the year 2000.

Basic general recreation facilities were specified for an estimated 2.5 million annual visits that would occur 3 to 5 years after completion and impoundment of water. Ultimate facilities are planned for 20 million annual visits which would be just about adequate to meet the estimated future demand.

The projected usage of these facilities, as reported by the two agencies, represents their experience in other sections of the United States and therefore the Engineers accept their basis for estimated deficits and estimated visitations. They have included in their area of influence nine highly industrialized and urbanized areas which are expected to generate 81.5% of the total visitations. Two of these areas, Pittsburgh and Erie, are in Pennsylvania. Erie with a reported population of 251,000 in 1960

is about 50 miles from the central proposed development, but Pittsburgh is located at the extreme perimeter of the 100-mile radius area. The Hammer Report has accepted a 2,405,000 population in 1960 for the Pittsburgh Standard Metropolitan Statistical Area (SMSA). This represents 30.8% of the total 7.8 million residents estimated to be within the zone of influence. However, the Pittsburgh SMSA is comprised of the total population of Beaver, Allegheny, Washington, and Westmoreland Counties. About 25% of the population of Allegheny and practically all of Washington and Westmoreland Counties are beyond the 100-mile radius of the project and therefore the residents of these areas are considered to be of minor consequence as potential users of recreational facilities which will be offered by the development of the project.

This would tend to reduce the Pittsburgh area participation by about 977,000 persons (1960 basis) for a total of 1,428,000 persons instead of the expected 2,405,000. The remaining area of influence within the Commonwealth of Pennsylvania, including Erie County, accounts for an additional 916,000 persons or a total for the state of 2,344,000, who might be regarded as visitors from Pennsylvania to Summit Reservoir recreational facilities in Ohio.

In summary, the Pittsburgh area population within the zone of influence is overstated and therefore the annual visitations are likewise overstated. Inasmuch as most of the benefits would accrue to Ohio, the benefits to Pennsylvania are deemed to be of minor importance.

The average annual recreation benefits are shown in the Hammer Report to be $22,800,000. The following tabulation shows the development of this figure and the Engineers' computation of these benefits:

General and Specialized Recreation Benefits

Project Years Applicable	Annual Value	Average Annual Benefit	Cumulative Benefits Basis
General Recreation:			
Years 1-4 (1975-1978)	$ 752,250	-	$ 3,009,000
Years 5-49 (1979-2023)	2,510,000	$ 2,510,000	112,950,000
Year 50 (2024)	30,075,000	19,034,000*	30,075,000
Subtotal		$21,544,000	$146,034,000
Fish and Wildlife Service:			
Fisherman Day Usage	1,172,000	1,172,000	58,600,000
Hunter Day Usage - Net	109,000	109,000	5,450,000
Total			210,084,000
Total Average Annual Benefits for Life of Project (50 years)		$22,825,000	$ 4,202,000
Rounded		$22,800,000	$ 4,200,000

(*) Annual value $30,075,000 - $2,510,000 = $27,565,000 increase; $27,565,000 increase discounted at .6905 = $19,034,000

The Engineers find it difficult to reconcile the benefits as stated in the Hammer Report. It would appear that the benefits for general recreation would jump from $2,510,000 on the 49th year to $30,075,000 on the 50th year which seems rather unreasonable. If the benefits are limited to the 50-year life of the project then the aforementioned $4.2 million average annual benefit would apply instead of the estimated $22.8 million average annual benefit. If the $30 million annual benefit shown for the 50th and subsequent years is intended to be average future benefit from 50th year on, even the $4.2 million figure is high. But in case it is intended that a gradual increase would be realized during the first 50 years reaching $30 million on the 50th year then the average for the life of the project would be $15.1 million not the $2.5 million as stated for the 5th to the 49th year in the Hammer Report.

Since the question arises as to the benefits beyond the 50-year project life the Engineers have discarded it in their

analysis as too speculative to justify consideration for the purpose of the present study.

Flood Control

Flood control was not considered a significant factor on the Grand River in the Hammer Report. Flood stage frequency curves were developed for designated flood damage districts in Warren, Youngstown, Wampum, and Beaver Falls on the Beaver and Mahoning Rivers under natural conditions. Stage frequency curves as modified by existing and planned reservoirs other than Summit Reservoir were made to show average reductions for floods varying from low to high magnitude from a review of all floods from 1936 to 1964, and for the maximum flood of record in 1913.

Natural Discharge Frequency

The Hammer Report graphs indicate that the natural discharge curves followed a theoretical statistical distribution for 10-year-and-over recurrent events which is not borne out by the data. Thus they found the 1913 flood as a 150- to 250-year recurrence in the flood damage districts. However, from the trend of the curve, the 1913 flood appears to have about a 500-year recurrence at Beaver Falls.

Flood Stages

The natural flood stage frequency curves were derived from natural discharge data. Also stage frequencies were derived to take into consideration existing and planned reservoirs, other than Summit Reservoir. However, since the discharge frequency used in the Hammer Report is high, the estimated stages of the river will be correspondingly high. As an illustration, the flood at Youngstown for the 100-year runoff is shown as natural stage elevation 25.5 ft in the Hammer Report, where the stage appears to be only 23.5 ft to the Engineers.

Controlled Tributary Area

The Hammer Report states that the controlled area is 452 square miles out of 898 square miles of tributary area above Youngstown. The Engineers find the controlled area to be 538 square miles which would give lower estimated stages with other then natural discharges.

Conclusions on Flood Damage

The zero damage stage selected in the Hammer Report occurs at Warren every 9 to 18 weeks; at Youngstown every 6 months to 1 year; at Wampum every year and year and one half; at Beaver Falls every 3 months to 1 year, depending on the number of control reservoirs without proposed canal development. Although the capacity of the stream has been diminishing, the recurrences appear much too frequent.

How much the yearly benefit of $2,750,000 would be reduced by a more reasonable estimate of natural discharge frequency and higher zero damage line cannot be determined from the information available in the Hammer Report.

The improved hydraulic capacity of the canal will eliminate flooding down to Beaver Falls. However, with the small amount of additional drainage area controlled by Summit Reservoir, it is difficult with the information in the Hammer Report to support the statement "the Grand River Reservoir (Summit Reservoir) on the average would reduce flooding in that reach of the Ohio River in the Pittsburgh District between one half foot to one foot from low to high floods".

Geology

The Engineers have reviewed the geologic data included in the Hammer Report. These data are attributed chiefly to a 1936 report by Dr. C.R. Fettke, a consultant geologist of Pittsburgh, who discussed the general geology and, in particular, the probable

extent of seepage. Subsequent detailed engineering geology based on additional bore holes has been done by the Army Engineers.

In general, the geologists were called upon to determine locations for locks and dams where good foundations would be available at reasonable depths and to investigate the probable seepage losses from Summit Reservoir. This work was carried out by using generally accepted methods in the necessary detail. The Hammer Report indicates that seepage from Summit Reservoir will not be significant and that all locks and dams will have good foundations.

On the basis of the data presented, the Engineers have no fault to find with the conclusions reached on dam locations and foundations. The Engineers accept that the formations underlying Summit Reservoir have a low permeability, but believe that there will be some seepage due to the new elevated free water surface.

Water Utilization

The planned use of available water to meet requirements for canal operation and for maintaining minimum flows in the rivers was reviewed by the Engineers. Summit Reservoir was planned near the summit to provide storage to balance seasonal variations in the natural inflow from tributary areas to the Grand and Mahoning Rivers. Also, the Army Engineers planned back pumpage from lower pools and from Lake Erie when necessary to meet operational requirements of the canalized Grand River.

Grand River Reservoir (Summit Reservoir)

The Hammer Report proposes a reservoir north of the ridge separating the two watersheds with a dam and locks on the Grand River at Harpersfield, a cut through the ridge and a dam and locks on the Mahoning River at Girard. The reservoir would be supplied from the Grand River drainage area of 556 square miles above the Harpersfield Locks and from the Mahoning River

drainage area of 895 square miles above the Girard Locks. Part of the inflow from the Mahoning River drainage area would be controlled by flood control dams and reservoirs on tributary streams. The above drainage areas were affirmed by the Engineers.

Reservoir Losses

The reservoir will introduce losses due to evaporation and infiltration materially exceeding those in the watershed under existing natural conditions. It is estimated that under average conditions the additional loss by evaporation from the reservoir surface area will approximate an equivalent runoff of 50 cfs. The report on the geology of the reservoir area indicates that the permeability of the underlying strata is low. However, with the relatively large area of a newly created reservoir bottom, and with the normal water level on the order of 80 ft to 100 ft above the ground surface to the north and below the proposed Harpersfield Dam, it is to be expected that there will be some loss from the reservoir by infiltration, or seepage. The Hammer Report does not show that these losses have been taken into account in its discussion of water supply and use.

Grand River

The Grand River has an average flow at Madison, Ohio, of 644 cfs based on the period 1922 to 1962. One half of the Grand River Reservoir storage was allocated in the Hammer Report to this section of the canal, to meet lockage and minimum flow requirements and it was estimated that lockage would require maximum flows of 1,000 cfs to 1,400 cfs. Any deficiency in water supply would be made up by backpumping from lower pools and from Lake Erie. The tributary inflow is adequate for minimum flow to meet dilution requirements for pollution control. With the planned backpumping of water to meet lockage requirements, no diversion of water from the Mahoning River drainage area is necessary for operation of the Grand River portion of the proposed canal.

Beaver and Mahoning Rivers

The total drainage area of the Beaver and Mahoning Rivers to Beaver Falls is about 3,150 square miles. The average runoff of the Mahoning River at Youngstown for the 1922 to 1960 period is given as 854 cfs by the United States Geological Survey. This was roughly checked by the Engineers from the reported median runoff of 12.16 in. for the 1922 to 1962 period at Youngstown as 810 cfs average runoff at Girard Locks. Flow at Girard Locks is approximately the same as at Youngstown. Water requirements for operation of Girard Locks were estimated in the Hammer Report to be 406 cfs without utilizing cross flow; the requirement for lockage at Beaver Falls was 810 cfs with two thirds of the filling using cross flow. There is an adequate water supply for operation of the Girard Locks, and with the inflow from tributary areas downstream, for the operation of all other locks including Beaver Falls, under average conditions. With the storage provided as shown, it appears that this supply is ample for lockage under minimum runoff conditions.

A Minimum Regulated Low-Water Schedule was developed by the United States Public Health Service (USPHS) for the Mahoning River at Youngstown to provide sufficient dilution for pollution control. Minimum flows required for the estimated levels of pollution in the indicated years are summarized below.

USPHS Minimum Regulated Low-Water Schedule
Mahoning River at Youngstown

	Cubic Feet per Second			
	1960	1980	2010	2060
Uncanalized	387	480	565	723
Canalized	584	663	756	966

The Hammer Report compared the amount of water available from runoff with minimum flow requirements for the canalized river

for two periods of record. The April 1930 to December 1934 period was selected for most severe drought conditions, and the May 1948 to March 1963 period was used as representative of average conditions. Reservoir storage computations were made giving consideration to inflow from each watershed and the allocation of the natural runoff to the corresponding river. Using an optimum schedule of flow regulation and the highest rates of the Minimum Regulated Low-Water Schedule, the reservoir storage remained above the minimum navigational level with one minor exception. From a result of studies and computations of runoff, storage, and flow regulation, the Hammer Report stated that for the average conditions of the 1948 to 1963 period, the minimum flow of the USPHS Regulated Low-Water Schedule at Youngstown was maintained or exceeded 25% of the time for the year 2060, 33% of the time for the year 2010, 41% of the time for the year 1980, and 100% of the time for the year 1960. A similar analysis for the 1930 to 1934 drought period was not presented. Rough computations for this period by the Engineers indicate that there would be insufficient water available from the Mahoning River watershed to meet the USPHS Schedule for the canalized river in 1960. Also, for one of the drought years October 1933 to September 1934, the amount of flow from storage and runoff just equaled the lockage requirements with the reservoir capacity fully utilized. Hence, any additional use, or loss such as the 50 cfs equivalent reservoir evaporation, would require diversion from the Lake Erie watershed for lockage without provision of minimum flow for pollution control.

Conclusions on Water Utilization

The Engineers concur with the Hammer Report conclusion that no benefits should be allowed for minimum flow regulation. This is based on the fact that the Grand River Reservoir, which has a capacity limited to the average annual runoff, can only provide storage to meet lockage requirements with consistency.

The proposed canal project will introduce factors at the expected water use which will lower water quality on the southern slope below acceptable standards which cannot be corrected by additional investment. The only practical corrective measure would be diversion from Lake Erie. The USPHS stated, ". . . with canalization, required flows . . . exceed average annual flows at Youngstown and water importation or utilization of technological development not yet known will be necessary".

Area Redevelopment Administration Benefits

The Engineers have reviewed the stated redevelopment benefits. These were the estimated wages, paid to local labor, that would be used in construction, maintenance and operation in the designated redevelopment areas, and production of the local materials used in the construction. The portions of the project located in Pennsylvania and in Ashtabula County, Ohio, are in redevelopment areas.

The proportion of cost of construction, operation and maintenance, and materials involved in the redevelopment localities was estimated, and then corrected for the portion that will be done by outside labor. Based on the information reported, the Engineers accepted the total moneys estimated to be spent for this purpose.

The Engineers have apportioned these benefits to the states on the basis of the redevelopment area in each state. The construction benefit was estimated to be prorated at 60% for Pennsylvania, 40% for Ohio. The maintenance and operation benefit was estimated at 35% for Pennsylvania and 65% for Ohio. These are shown below as annual benefits:

	Annual Benefit for Years Outlined		
	Pennsylvania	Ohio	Total
	(in thousands)		
Construction			
$70,130,000 distributed in seven equal annual local payrolls starting in the beginning of construction	$ 6,012	$ 4,008	$10,020
Materials of Construction			
$54,000,000 distributed in seven equal payments to local labor starting with the beginning of construction	4,632	3,088	7,720
Operation and Maintenance			
Wages paid each year to local labor for the first 20 years of the project life, beginning with the completion of construction	198	368	566

These benefits accruing for the most part during the 7-year construction period were converted in the Hammer Report using annuity and discount factors to arrive at an annual average Area Redevelopment Administration benefit for the 50-year life of the project of $5,620,000. The Engineers do not necessarily agree with the methodology; however, the resulting benefit has been accepted for the purpose intended.

SUMMARY OF AVERAGE ANNUAL BENEFITS AND COSTS

The estimated benefits resulting from the proposed canal, as previously discussed, are summarized in the following table:

Summary of Average Annual Benefits
(thousands of dollars)

	Hammer Report	Revised Report (A)	Engineers' Estimates Potential	Engineers' Estimates Probable
Navigation	$ 87,510	$ 68,500	$71,410	$44,070
Recreation	22,800	22,800	4,200	4,200
Flood Control	2,750	2,750	2,750	2,750
Area Redevelopment	5,620	5,620	5,620	5,620
Total Annual Benefits	$118,680	$ 99,670	$83,980	$56,640
Rounded	$119,000	$100,000	$84,000	$57,000

Note: (A) Hammer Report as amended by Cincinnati Division Engineer, Corps of Engineers

The benefits, based upon the wording used in the Hammer Report "The average annual......benefit adjusted to present worth on the basis of 3-1/8 per cent interest would be...... .", are not clear. In the Engineers' opinion the average annual benefit derived as the arithmetic average over the 50-year life of the project should be used for comparison with annual costs. When the arithmetic 50-year life averages are used for navigation and recreation benefits, the corresponding total benefits would be $106,000,000 and $86,000,000, respectively, for the Hammer and Revised Reports.

A comparison of estimated annual charges and benefits and the ratio of benefits to charges are presented below. Area Redevelopment Administration benefits have been included although they are somewhat vague in nature.

Comparison of Benefits and Annual Costs
(thousands of dollars)

	Annual Charges	Average Annual Benefits (A)	Benefit-to-Cost Ratio
Hammer Report:			
As Stated	$54,200	$119,000	2.2 to 1
50-Year Average	54,200	106,000	2.0 to 1
Revised Report: (B)			
As Stated	54,200	100,000	1.8 to 1
50-Year Average	54,200	86,000	1.6 to 1
Engineers' Estimate:			
Potential	72,200	84,000	1.2 to 1
Probable	72,200	57,000	0.8 to 1

Note: (A) Includes Area Redevelopment Administration Benefit.

(B) Hammer Report as amended by Cincinnati Division Engineer, Corps of Engineers.

The Engineers' estimated benefit-to-cost ratio of 0.8 to 1 indicates that the estimated annual Federal and non-Federal charges exceed the expected benefits, including Area Redevelopment benefits, by over $15,000,000 each year.

EFFECT OF PROPOSED CANAL ON ECONOMY OF PENNSYLVANIA

The Engineers have been asked to comment on the economic effect of the proposed canal on Pennsylvania. It would appear that the estimates of potential traffic show savings for certain Pennsylvania shippers. A project of this magnitude should be approached objectively, appraising its effect upon industry, present transportation agencies, water supply, flood control, and recreation.

Mining

Of the 14,100,000 tons of bituminous coal potential to the canal 1961 origin, the Pittsburgh, Butler, and Mercer districts of western Pennsylvania originate only about 10%, of which a high percentage is from captive mines and, therefore, would continue to move whether or not a canal is provided. Another 36% of the potential tonnage is steam coal from Ohio No. 8 district, and would use the cheapest available transportation to the southern shore of Lake Erie. The remaining 54% of the canal's potential coal tonnage originates in West Virginia and Kentucky, and given cheaper access to Lake Erie by a reduction in transportation costs, these premium coals might make further inroads on markets now served by Pennsylvania mines.

Pennsylvania coal seams are usually narrower then those in West Virginia and Kentucky, and as a result, man-hour and total daily output in Pennsylvania are lower. At present, rail and truck transportation are available at the same basic rates for Pennsylvania mines shipping 300 tons and for Southern mines shipping 3,000 tons a day. Although the latter production could fill three 1,000-ton barges a day, the former would require more than 3 days to fill a single barge. Therefore, the waterway will give the heavy tonnage mines a definite advantage over small-

volume producers. The heavy tonnage mines have a similar advantage under unit or integral train rates.

Manufactured Products

Detroit's automotive industry constitutes a major market for products of both the Pittsburgh and Youngstown districts. It appears that the two districts would share proportionately in reduced transportation costs by water shipment but that with an intermediate location Youngstown would retain its present advantage. The canal would enable southbound iron and steel tonnage originating in the Youngstown area to compete on equal terms for Southern and Western markets already accessible by barge from Pittsburgh mills. Likewise, the waterway would make it easier for Ohio building materials to penetrate western Pennsylvania at the expense of similar products from central Pennsylvania.

The proposed waterway would make it possible for heavy industrial firms in the proximity of the canal or along the Lake Erie shore to produce the extremely large components, which cannot be shipped by rail, for nuclear and space exploration requirements. Thus firms in the Erie, Pa., area would conceivably benefit from increased opportunities for business.

An alternative protected route may eventually be possible through the Champlain waterway, now under study, although movement by either route would be restricted to navigation seasons on the Great Lakes.

Industrial Sites

The Youngstown, Ohio, interests are the waterway's prime supporters since this area would be the major recipient of benefits from the proposed canal. As presently conceived, this area would gain, at general public expense for the most part, the advantages of inland waterways that western Pennsylvania was endowed with by nature.

The first 15 or so miles of the proposed canal in the high bluff area of the Beaver River Valley offers limited areas for industrial development contiguous to the canal. The northern end of the Beaver River Valley and the Mahoning River Valley in Pennsylvania provide extensive areas ideally suited for plant locations adjacent to the banks of the waterway. Since only about 30 miles of the system would be in Pennsylvania, Ohio with the remaining 90 miles of waterway and extensive Lake Erie shoreline could offer a wider selection of plant sites. On the other hand, industrial sites on the Allegheny, Monongahela, and Ohio Rivers in Pennsylvania could be more attractive with the water outlet to the Great Lakes and St. Lawrence Seaway.

Transportation Agencies

The Hammer Report estimated that, on the current rate basis, the annual potential canal tonnage (based on 1975) would be 68,800,000 tons. Based on the current average ton rate of $2.12 this equals a total revenue loss to present carriers of $145,856,000 per year. Regardless of whether all of the above tonnage is actually diverted to the canal or not, reduced rates on the waterway will result in drastic reduction in freight revenues of carriers in the area. If they choose to reduce rates to the very minimum, the present carriers will be placed in a position of hauling freight at very near the incremental cost and the contribution formerly made to overhead and fixed charges by this traffic will have to be foregone or made up on other freight which either because of its low volume or wide distribution is not subject to carriage via barge.

This loss of traffic would result in significant reductions in train frequency in the area as well as general reductions in terminal and yard classification functions, locomotive and car repair, much of which is concentrated in the Pittsburgh area and

employing many people. While these reductions in common carrier service would not be serious to large shippers of bulk products located on or near the waterways, they could seriously affect the competitive position of shippers not located near the canal or river or who cannot ship in large-lot volumes.

With the possible exception of pipe shipments to the Southwest and steel destined to the automotive industry in the Detroit area, the barge offers much less advantage to shippers of finished products because of the wide distribution of the market and the additional shipping time and extra handling involved in barge transport. In recent years the trucks have captured significant tonnage of these finished products because of the tendency to expedite delivery, reduce handling costs, and reduce inventories. In fact, the recent trend of steel plant construction at points outside the Pittsburgh area has been due in part to the advantages of producing steel closer to the consumer to reduce the shipping costs of finished products. The tonnages in products other than coal, ore, and limestone represent a small portion of the tonnage allocated in the Hammer Report to the canal, but a significant part of the transportation savings. There is less likelihood that the land carriers can make such drastic reductions in the tariff rates on these products as they do not lend themselves to large-volume movements as readily as bulk commodities.

It is reasonable to assume that considerable tonnages of finished products will be lost to the railroads and trucks where they move in sufficient volume to justify large lots.

CONCLUSIONS

The Army Engineers have studied and made numerous proposals for the reinstitution of the Lake Erie-Ohio River inland waterway since the original canal failed in 1871. At least five different routes, each including alternate lake terminal sections have been proposed over the years with recent reports centering on the Beaver-Mahoning-Grand River Valleys route. The current Hammer Report recommends this route with the Lake Erie terminus at Fairport, Ohio.

The proponents and opponents of the canal project have changed little with time. The principal proponents are found in the Youngstown-Girard-Niles-Warren, Ohio, area which has promise of economic gain from the proposed water transportation. The opponents, on the other hand, mainly represent geographic areas and existing transportation agencies which stand to be adversely affected by the proposed canal.

The canal as proposed in the Hammer Report would extend from the confluence of the Ohio and Beaver Rivers northward up the Beaver River to its junction with the Mahoning River, thence northwest up the Mahoning through Youngstown to Warren, Ohio, where the canal would be constructed across country in a northerly direction to intersect the Grand River which would be dammed to form an artificial lake extending to Harpersfield, Ohio. From Harpersfield the canal would follow the Grand River in a westerly direction to Painesville and thence north via a cut to the Lake Erie shore at Fairport Harbor. The waterway would have a minimum channel depth of 18 ft and a bottom width of 300 ft, except in the congested Youngstown and Warren areas where the width would be 200 and 250 ft, respectively. The section south of Summit Reservoir would have seven dams for water level control from the Ohio

River elevation of 682 ft to the summit at elevation 841. Three additional dams would accommodate the drop from the summit to Lake Erie at elevation 570. All dams would be equipped with dual 84 x 720 ft locks for navigation.

The Engineers reviewed the Hammer Report construction estimates for major cost items and noted several points of variance having material effect on the project cost, as follows:

Estimated Additional Construction Cost of Major Project Items

Item	Estimated Additional Cost
Excavation	$ 74,989,000
Highway and Railroad Bridges, and Relocations	12,171,000
Locks and Dams	16,052,000
Lake Erie Harbor Dredging	3,100,000
Utilities	879,000
Total	$107,191,000

Associated costs which are based on a percentage of construction cost (engineering and design, and supervision and administration) would increase the above total correspondingly.

The estimates are based upon 1964 cost levels as are the other financial computations relating to the project. However, considering a start of construction 3 years hence and running for 7 years means that 1971 would be the midpoint or average-cost year. The Engineering News-Record Cost Index for 1958-1964 trended on a straight line to 1971 indicates that construction costs would have increased 19% by the average-cost year of the project.

In the Engineers' opinion, the estimated 7-year construction period is a minimum for the size and complexity of the

proposed waterway and any extension of this period will materially increase project costs.

The Engineers find that the estimated Federal first costs, including interest during the construction period, should be increased $180,000,000 or from $1,052,000,000 to $1,232,000,000.

The Engineers also find that the estimated non-Federal first costs, including interest during the construction period, should be increased from $85,000,000 to $91,000,000. Additional first costs for Fairport Harbor and expected user terminal facilities bring the Engineers' estimated non-Federal investment to $214,000,000.

Approximately 55% of the estimated $91,000,000 non-Federal first cost would be of a public nature with the other 45% involving private ownership.

The major portion amounting to about 92% of the non-Federal first costs involves facilities in the State of Ohio leaving only 8% Pennsylvania interests.

The annual fixed and direct costs of canal operation are for a large part dependent upon financing costs. The 3-1/8% interest rate used for all financing in the Hammer Report does not reflect the actual costs involved. Based upon interest rates of 4-1/4% for Federal, 4-3/4% for private, and 3-1/8% for non-Federal public borrowings, the estimated annual fixed and direct cost of operations would be about $72,200,000 or $18,000,000 higher than the Hammer Report estimate.

The Hammer Report estimates for floating equipment requirements, or navigational units, followed the general practice of barge line operators in the number of barges, except for spares, to be provided for general bulk cargo service. However, for the petroleum and chemical service only the moving units were considered, thus understating the computed rates for these trades. It was also noted that the reduced barge capacity for a control-

ling depth of 9 ft in the Ohio River system concept was not followed in all cases, which also understated the derived water transportation rates.

The Engineers' estimated water transportation rates are approximately 31% higher for several reasons, but mainly due to the use of Ohio River operating towing companies' recommended towing speeds for the waterway. The Cincinnati Division Engineer's review of the Hammer Report also states that towing speeds used in the report were excessive.

The Engineers estimate that an investment of over $96,000,000 will be required to provide bulk cargo handling facilities at Fairport Harbor to handle the traffic. Public financing of this investment and the operation thereof by the Port of Fairport or similar public authority have been assumed to arrive at the following cargo transfer rates applicable to the major portion of the bulk traffic.

	Per Ton
Iron Ore	
1. Unloading lake vessels to barges or storage	$0.16095
2. Loading barges from storage	.15829
3. Combined rate for passage through Port	$0.31924
Coal	
1. Unloading barges to storage	$0.13193
2. Loading lake vessels from storage	.12443
3. Combined rate for transshipment	$0.25636

These rates reflect 100% utilization of facilities designed to handle the potential annual tonnage of 32,000,000 for each type of operation and would have to be adjusted upward for actual tonnages below the design capacity.

It was assumed in the Hammer Report that potential users of the waterway would install at their own expense equipment for in-plant handling of transported materials. The Engineers estimated that a typical installation for transfer of ore, coal, or limestone with a design capacity of 3,000,000 tons annually would require an investment of $2,915,000 at each such industrial complex. The cost per ton of material handled on this basis would be about $0.20 which with a satisfactory return on investment would increase to 29.2 cents per ton. Even higher rates per ton would apply for mills requiring a design capacity of 1,000,000 or less annually. If only the expected users of the canal install such facilities, an investment of about $26,235,000 would be required.

The Engineers reviewed the potential traffic forecast for the canal and developed tonnages which indicated the estimates were acceptable for the purpose. Success in diverting this tonnage will depend on the differential between barge and railroad rates in effect after completion of the waterway and the economics of installing handling facilities for this new mode of transportation. Traffic on the canal will build up over a period of years as economics dictate, but in the Engineers' opinion the total forecast potential will not be effective in producing navigational benefits for the proposed project. The annual probable navigation benefits are estimated by the Engineers to average $44,070,000 over the 50-year life of the project.

The Engineers deemed that the recreation benefits accruing to the State of Pennsylvania would be of minor importance. The estimated average annual recreation benefit of $22,800,000 apparently includes benefits accruing beyond the 50-year life of the project, which is too speculative. Based on the Hammer Report schedule of benefits, the Engineers conclude

that the annual recreation benefits over the 50-year project life would average $4,200,000.

The flood control benefit credited to the project is not significant and has been accepted as reasonable by the Engineers. However, the claim that Summit Reservoir would, on the average, reduce flooding in the Pittsburgh district of the Ohio River by as much as 1 ft in high floods is questionable.

The Engineers concur that no water utilization benefits accrue for minimum stream flow regulation. It is also noted that the expected water use for the canal will lower water quality on the southern slope below U.S. Public Health Service acceptable standards.

The Engineers accepted the Area Redevelopment Administration benefits as shown, although they are of a speculative nature. The construction portion of the benefit was estimated, by the Engineers, to be prorated at 60% for Pennsylvania and 40% for Ohio and the maintenance and operation benefit prorated at 35% and 65%, respectively, based on the proportion of affected redevelopment area in each state.

The Engineers conclude that the average annual benefit for each category should be derived as the arithmetic average over the 50-year life of the project instead of as stated in the Hammer Report where "the average annual....benefit adjusted to present worth on the basis of 3-1/8% interest would be.... ." which is misleading. The following comparison of annual charges and benefits and the ratio of benefits to charges indicate that in the Engineers' opinion the project with an 0.8 to 1 ratio is not feasible:

Comparison of Benefits and Annual Costs
(thousands of dollars)

	Annual Charges	Average Annual Benefits (A)	Benefit-to-Cost Ratio
Hammer Report:			
As Stated	$54,200	$119,000	2.2 to 1
50-Year Average	54,200	106,000	2.0 to 1
Revised Report: (B)			
As Stated	54,200	100,000	1.8 to 1
50-Year Average	54,200	86,000	1.6 to 1
Engineers' Estimate:			
Potential	72,200	84,000	1.2 to 1
Probable	72,200	57,000	0.8 to 1

Note: (A) Includes Area Redevelopment Administration benefit.

(B) Hammer Report as amended by Cincinnati Division Engineer, Corps of Engineers.

It appears to the Engineers that the effect of the proposed canal on the economy of Pennsylvania would be of a negative nature. Certain intangible benefits will accrue to the Commonwealth along with minor portions of those more readily assessed. The opportunity for transportation savings, future industrial growth, and other benefits seems to favor the State of Ohio. Its extensive Lake Erie shoreline which, with the proposed waterway, would offer expanded marketing possibilities at minimum transportation rates, may pose a threat to the congested Pittsburgh area.

EXHIBITS

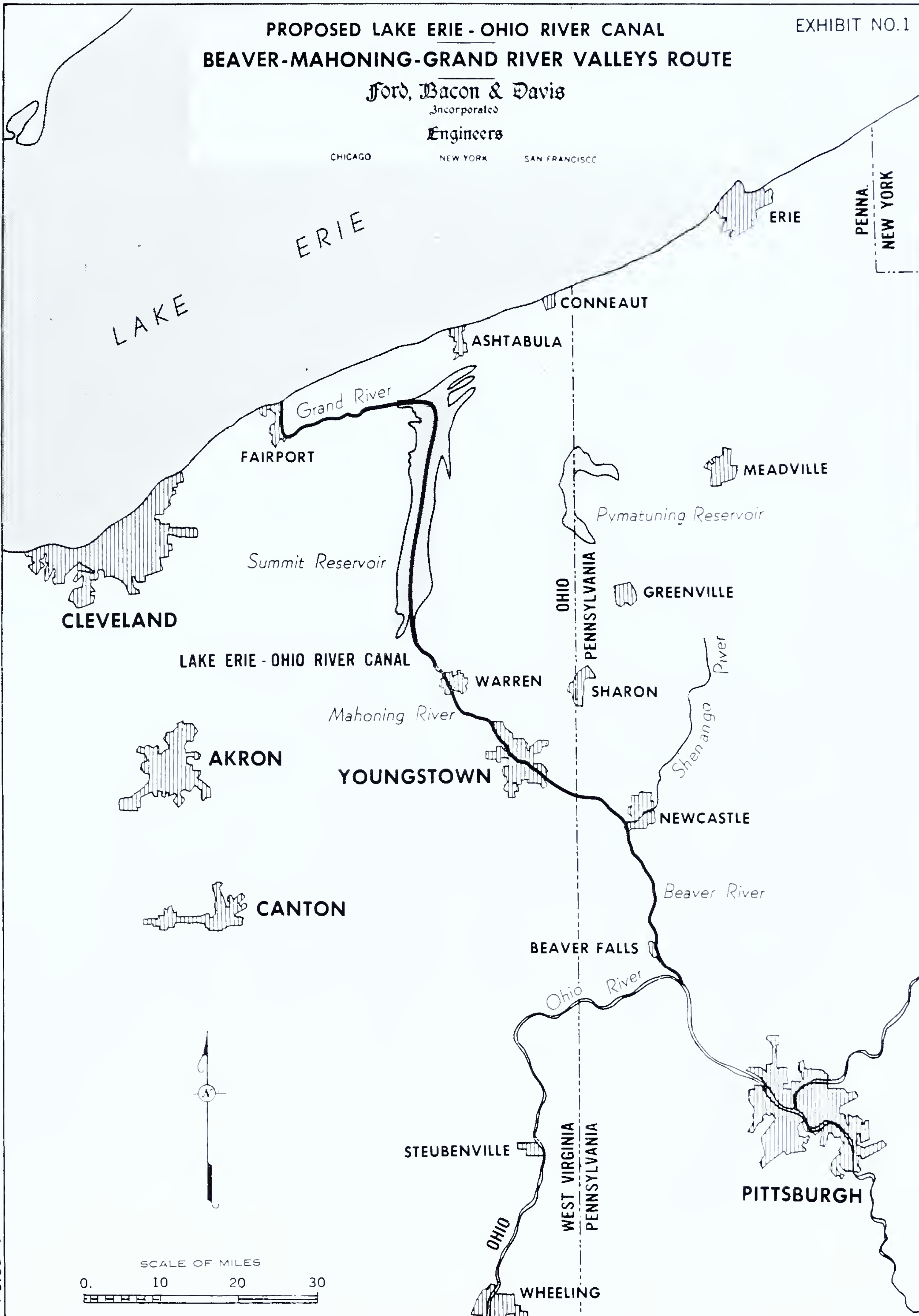

PROPOSED LAKE ERIE - OHIO RIVER CANAL
BEAVER-MAHONING-GRAND RIVER VALLEYS ROUTE
Ford, Bacon & Davis
Incorporated
Engineers
CHICAGO
NEW YORK
SAN FRANCISCO
EXHIBIT NO.1
LAKE ERIE
ERIE
PENNA.
NEW YORK
CONNEAUT
ASHTABULA
Grand River
FAIRPORT
MEADVILLE
Pymatuning Reservoir
Summit Reservoir
CLEVELAND
OHIO
PENNSYLVANIA
GREENVILLE
LAKE ERIE - OHIO RIVER CANAL
WARREN
SHARON
Shenango River
Mahoning River
AKRON
YOUNGSTOWN
NEWCASTLE
Beaver River
CANTON
BEAVER FALLS
Ohio River
STEUBENVILLE
WEST VIRGINIA
PENNSYLVANIA
PITTSBURGH
OHIO
SCALE OF MILES
0.
10
20
30
WHEELING
T-6189-6-8-65 A

Exhibit No. 2

Proposed Lake Erie-Ohio River Canal
Allocation of Non-Federal First Costs
Between Pennsylvania and Ohio

	Pennsylvania			Ohio			Total		
	Hammer Report	Engineers' Estimate	Increase	Hammer Report	Engineers' Estimate	Increase	Hammer Report	Engineers' Estimate	Increase
Rights of Way	$ 895,000	$ 895,000	-	$13,607,000	$13,607,000	-	$14,502,000	$14,502,000	-
Steel Company Bridges & Relocations		None		7,915,000	8,933,000	$1,018,000	7,915,000	8,933,000	$1,018,000
Highway Bridges & Relocations (A)	1,310,000	1,387,000	$ 77,000	1,387,000	1,452,000	65,000	2,697,000	2,839,000	142,000
Railroad Bridges & Re-locations (A)	878,000	1,004,000	126,000	1,423,000	1,577,000	154,000	2,301,000	2,581,000	280,000
Water Intakes & Outfalls:									
Public Ownership	214,000	220,000	6,000	-	-	-	214,000	220,000	6,000
Private Ownership	265,000	272,000	7,000	15,054,000	15,477,000	423,000	15,319,000	15,749,000	430,000
Subtotal	479,000	492,000	13,000	15,054,000	15,477,000	423,000	15,533,000	15,969,000	436,000
Sewer, Water Supply, & Drainage Facilities	771,000	793,000	22,000	3,564,000	3,664,000	100,000	4,335,000	4,457,000	122,000
Utilities:									
Gas Pipelines	813,000	836,000	23,000	1,037,000	1,066,000	29,000	1,850,000	1,902,000	52,000
Product Pipelines	59,000	61,000	2,000	225,000	231,000	6,000	284,000	292,000	8,000
Telephone	305,000	313,000	8,000	523,000	538,000	15,000	828,000	851,000	23,000
Electric	159,000	164,000	5,000	3,660,000	3,763,000	103,000	3,819,000	3,927,000	108,000
Subtotal	1,336,000	1,374,000	38,000	5,445,000	5,598,000	153,000	6,781,000	6,972,000	191,000
Total	5,669,000	5,945,000	276,000	48,395,000	50,308,000	1,913,000	54,064,000	56,253,000	2,189,000
Non-Federal Share of Joint Costs Allocated to Recreation	-	-	-	23,203,000	23,203,000	-	23,203,000	23,203,000	-
Total Non-Federal Costs	$5,669,000	$5,945,000	$276,000	$71,598,000	$73,511,000	$1,913,000	$77,267,000	$79,456,000	$2,189,000
Identifiable Private Ownership	$2,479,000	$2,650,000	$171,000	$29,837,000	$31,585,000	$1,748,000	$32,316,000	$34,235,000	$1,919,000
Balance - Public Ownership	3,190,000	3,295,000	105,000	41,761,000	41,926,000	165,000	44,951,000	45,221,000	270,000

Note: (A) Apportioned under Truman-Hobbs Act, as amended.

Proposed Lake Erie-Ohio River Canal
Federal Annual Fixed and
Direct Costs of Canal Operation

	Hammer Report	Engineers' Estimate
Interest on Net Federal Investment	$32,900,000(1)	$52,369,000(2)
Adjustment for Net Loss of Productivity on Land	1,200,000(3)	480,000(4)
Amortization of Net Federal Investment	8,900,000(5)	7,411,000(6)
Maintenance and Operation	8,300,000	8,300,000
Allowance for Major Replacement of Recreational Facilities	500,000	500,000
Total Federal Annual Charges	$51,800,000	$69,060,000

Note: (1) 3-1/8% interest on $1,052,000,000

(2) 4-1/4% interest (average current interest rate on Federal borrowing) on $1,232,223,000

(3) 5% - 3-1/8% x market value of land for reservoir and recreation

(4) 5% - 4-1/4% x market value of land for reservoir and recreation

(5) Sinking fund at 3-1/8% (0.854% of $1,043,000,000)

(6) " " " 4-1/4% (0.606% of $1,223,223,000)

Proposed Lake Erie-Ohio River Canal
Non-Federal Annual Fixed and
Direct Costs of Canal Operation

	Hammer Report	Engineers' Estimate
Interest on Net Non-Federal Investment	$2,700,000(1)	$3,502,000(2)
Adjustment for Net Loss of Productivity on Land	200,000(3)	247,000(3)
Amortization of Net Non-Federal Investment	700,000(4)	641,000(5)
Maintenance and Operation	400,000	400,000
Total Non-Federal Annual Charges	$4,000,000	$4,790,000

Note: (1) 3-1/8% interest on $85,000,000

(2) 3-1/8% interest on $50,500,000 public investment
4-3/4% interest on $40,500,000 private investment

(3) 5% - 3-1/8% x market value of land from Ohio River to Warren, Ohio

(4) Sinking fund at 3-1/8% (0.854% of $85,000,000)

(5) Sinking fund at 3-1/8% (0.854% of $50,500,000) public investment
Sinking fund at 4-3/4% (0.517% of $40,500,000) private investment

Exhibit No. 4

Proposed Lake Erie-Ohio River Canal
Estimated Monthly Operating Costs of
Navigational and Operating Units

	1,500-hp Towboat	2,000-hp Towboat	Open Barge 26' x 175'	Covered Canal Barge 35' x 195'	Covered Lake Barge 35' x 195'
First Cost of Navigational Unit	$410,000	$570,000	$ 46,000	$ 83,000	$120,000
Fixed Charges					
Interest @ 1.44%	492	684	55	100	144
Insurance - Current Average, 2.2%	752	1,045	-	-	-
" - " " , 1.5%	-	-	58	104	150
Total Fixed Charges and Insurance	1,244	1,729	113	204	294
Operating Expenses					
Maintenance and Supplies	4,260	5,680	118	151	180
Fuel and Lube Oil	4,200	5,600	-	-	-
Crew - Pittsburgh Pool Basis *	21,181	21,181	-	-	-
Depreciation - 16-2/3 years	2,050	2,850	-	-	-
" - 20 years	-	-	192	346	500
Subtotals	31,691	35,311	310	497	680
Overheads	4,446	4,869	18	23	32
Total Operating Expenses	36,137	40,180	328	520	712
Total Operating Costs per Unit (including Fixed Charges and Insurance)	$37,381	$41,909	$441	$724	$1,006

Monthly Operating Expenses for Complete Navigation Unit

	Open Barge, 1,500-hp	Open Barge, 2,000-hp	Covered Canal Barge, 2,000-hp	Covered Lake Barge 2,000-hp	Covered Lake Barge 1,500-hp
No. Towboats	1	1	1	1	1
No. Barges	34	34	25	25	6
Monthly Operating Costs:					
Towboats	$37,381	$41,909	$41,909	$41,909	$37,381
Barges	14,994	14,994	18,100	25,150	6,036
Complete Nav. Unit Cost per Month	$52,375	$56,903	$60,009	$67,059	$43,417

Note: *
Crew Cost Based on an average of 15.2 days worked per month or wages listed x 2 = approximate wage cost per boat.

	Monthly Wage	No. in Crew	Monthly Cost
Captain	$980	1	$ 1,960
Pilot	841	1	1,682
Mate	643	1	1,286
Chief Engr.	841	1	1,682
Asst.	802	1	1,604
Watchman	511	1	1,022
Deckhand	474	4	3,792
Striker	474	1	948
Cook	509	1	1,018
Steward	421	1	842
Subtotal		13	15,836
Fringe Benefits and Other Wage Costs		25%	3,959
Supplies - $.25/D/Man			98
Subsistence - $2.50/D/Man			975
Transportation of Crew			208
Communications - $3.50/D			105
Total Crew Cost per Month			$21,181

Proposed Lake Erie-Ohio River Canal
Computation of Costs and Rates per Ton

Trade 1

For open barge coal haul on rivers and canal north to Youngstown, Ohio (Trade 1 in "Review of Reports")

Assumed Distances

Ohio River	100	mi
Canal - Wide	25	"
" - Restricted	20	"
Total One Way	145	"
Locks One Way	14	

Calculations	1,500 Hp Speed	1,500 Hp Hours	2,000 Hp Speed	2,000 Hp Hours
Running Time:				
Reach -				
Ohio Loaded	5.3	19.0	5.7	17.5
Canal, Loaded, Wide	4.5	5.6	4.8	5.2
Canal, Restricted, Loaded	3.4	6.0	3.6	5.6
Canal, Restricted, Light	4.2	4.8	4.5	4.5
Canal, Light, Wide	5.3	4.7	5.7	4.4
Ohio, Light	6.4	15.6	6.8	14.7
Locking		14.0		14.0
Terminals		2.0		2.0
Total Normal Running		71.7		67.9
Delays 20%		14.3		13.6
Total Trip Time		86.0		81.5
Trips/Mo. of 700 Hr		8.14		8.59
Tons/Mo.		80,586		85,041
Ton-Miles/Mo. (Millions)		11.68		12.33
Investment:				
Towboat		$ 410,000		$ 570,000
Barges (34 @ $46,000)		1,564,000		1,564,000
Total Inv.		1,974,000		2,134,000
Cost and Rates:				
Net Profit/Yr		$ 118,440		$ 128,040
Gross Profit/Yr		246,750		266,750
" " /Mo.		20,563		22,229
Cost/Mo. - Barge & Towboats		52,375		56,903
Revenue/Mo.		$ 72,938		$ 79,132
Cost/Ton-Mile (mills)		4.48		4.62
Rate/Ton-Mile (mills)		6.24		6.42
Rate/Ton		$0.905		$0.931

Proposed Lake Erie-Ohio River Canal
Computation of Costs and Rates per Ton

Trade 2

For covered canal barge haul coal north to Lake Erie and one south to Ohio, Monong. & Allegh. Rivers (Trade 2 in "Review of Reports")

Assumed Distances	
Ohio River	100 mi
Canal	88 "
Canal - Restricted	20 "
Total One Way	208 "
Locks One Way	21

Calculations

	Loaded Both Ways Speed	Loaded Both Ways Hours		1/3 Loaded South Speed	1/3 Loaded South Hours
Running Time:					
Reach -					
Ohio, Loaded	6.4	15.6		6.4	15.6
Canal, Loaded	5.4	16.3		5.4	16.3
Canal, Restricted, Loaded	4.0	5.0		4.0	5.0
Canal, Restricted, Light	4.0	5.0		4.5	4.5
Canal, Light	5.4	16.3		6.2	14.2
River, Light	6.4	15.6		7.0	14.3
Locking		21.0			21.0
Terminal		2.0			2.0
Total Normal Running		96.8			92.9
Delays 20%		19.4			18.6
Total Trip Time		116.2			111.5
Trips/Mo. of 700 Hr		6.02			6.28
Tons/Mo.		99,691	Coal		49,845
" "		-	Ore		16,615
			Total		66,460
Ton-Miles/Mo. (Millions)		20.74	Coal		10.37
" " " "		-	Ore		3.46
			Total		13.83
Investment:					
Towboat					$ 570,000
Barges (25 x $83,000)					2,075,000
Total Investment					$2,645,000
Cost and Rates:					
Net Profit/Yr		$158,700			$158,700
Gross Profit/Yr		330,625			330,625
" " /Mo.		27,552			27,552
Cost/Mo. - Barge & Towboats		60,009			60,009
Revenue/Mo.		$ 87,561			$ 87,561
Cost/Ton-Mile (mills)		2.89			4.34
Rate/Ton-Mile (mills)		4.22			6.33
Rate/Ton		$0.878			$1.317

Proposed Lake Erie-Ohio River Canal
Computation of Costs and Rates per Ton

Trade 3

For covered canal barge haul coal north to Lake Erie and to Lake Erie ports and ore south to Ohio, Monong. & Allegh. Rivers (Trade 3 in "Review of Reports")

Assumed Distances

Ohio River	100 mi)		
Canal - Wide	88 ")	208 mi (ore)	
" - Restricted	20 ")		
Lake Erie	100 "		
Total One Way	308 "	(coal only)	
Locks	21		

Calculations

Running Time:

	River & Canal Phase
River	31.2 Hr
Canal - Wide	32.6 "
Canal - Restricted	10.0 "
Locking	21.0 "
Terminal	2.0 "
	96.8 "
Delays 20%	19.4 "
Total Trip Time	116.2 "
Trips/Mo. of 700 Hr	6.02
Tons/Mo.	93,190
Ton-Miles/Mo. (Millions)	19.38

	Lake Phase (2 barge tow)
Running Time:	
Loaded, mph	11.1 Hr
Empty, 11 mph	9.1 "
Terminal	4.0 "
Normal Running	24.2 "
Delays 27%	6.5 "
Total Running	30.7 "
Trips/Mo. of 700 Hr	22.80
Tons/Mo.	58,824
Ton-Miles/Mo. (Millions)	5.88

Investment:	River & Canal Phase		Lake Phase
Towboat	$ 570,000	Towboat	$ 410,000
25 Barges	3,000,000	6 Barges	720,000
	$3,570,000		$1,130,000
8/12 Yr	2,380,000		753,000

Cost and Rates:

	River & Canal Phase	Lake Phase
Net Profit/Mo.	$ 17,850	5,648
Gross Profit/Mo.	37,188	11,767
Cost/Mo. - Towboats & Barges	67,059	43,417
Revenue/Mo.	104,247	55,184
Cost/Ton-Mile (mills)	3.46	7.38
Rate/Ton-Mile (mills)	5.38	9.39
Rate/Ton	$1.119	$0.938

Combined Coal Rate
$1.119
0.938
$2.057/Ton
6.68 Mills/Ton-Mi.

Ore Rate
$1.119/Ton
5.38 Mills/Ton-Mi.

Proposed Lake Erie-Ohio River Canal
Lake Erie Terminus - Piers and Bulk Cargo Facilities - Non-Federal First Costs

	Ore Facilities			Coal Facilities			
	Unload Lake Vessels to Barge or Storage	Load Barges from Storage Pile	Total	Unload Canal Barges to Storage	Load Lake Vessels from Storage Pile	Total	Total Erie Terminal
Piers and Mooring Cells	$ 7,329,500	$ 7,329,500	$14,659,000	$8,265,000	$8,265,000	$16,530,000	$31,189,000
Bulk Cargo Handling Equip.							
Clamshell Bucket Unloader, Capacity 1,000 T/Hr, 8 Units @ $1,500,000	12,000,000		12,000,000				
Clamshell Bucket Loader, Capacity 800 T/Hr, 10 Units @ $700,000		7,000,000	7,000,000				
Rotary Bucket Wheel (stockpile and reclaiming), Capacity 3,500 T/Hr, 3 Units @ $1,000,000	1,000,000	2,000,000	3,000,000				
Crane Track & Supports	500,000	500,000	1,000,000				
Conveyors (belt)	1,000,000	1,500,000	2,500,000				
Ladder-type Barge Unloader, Capacity 1,500 T/Hr, or 30,000 T/D, 3 Units @ $750,000				2,250,000		2,250,000	
Clamshell Bucket Ship Loader, Capacity 1,500 T/Hr, or 30,000 T/D, 3 Units @ $800,000					2,400,000	2,400,000	
Rotary Bucket Wheel (stockpile and reclaiming), Capacity 4,000 T/Hr, or 80,000 T/D, 2 Units @ $1,000,000				1,000,000	1,000,000	2,000,000	
Conveyors				1,000,000	1,000,000	2,000,000	
Crane Track & Supports				500,000	500,000	1,000,000	
Total Bulk Cargo Handling Equip.	$14,500,000(A)	$11,000,000(A)	$25,500,000(A)	$ 4,750,000(B)	$ 4,900,000(B)	$ 9,650,000(B)	$35,150,000

Note: (A) Based on 32,000,000 T/Yr
160,000 T/D
8,000 T/Hr

(B) Based on 16,000,000 T/Yr
80,000 T/D

Proposed Lake Erie-Ohio River Canal

Lake Erie Terminus - Piers and Bulk Cargo Facilities - Non-Federal First Costs

	Ore Facilities			Coal Facilities			
	Unload Lake Vessels to Barge or Storage	Load Barges from Storage Pile	Total	Unload Canal Barges to Storage	Load Lake Vessels from Storage Pile	Total	Total Erie Terminal
Tugboat Service in Terminal							
Terminal Tugboats, 6 Units @ $300,000	$ 800,000	$ 400,000	$ 1,200,000	$ 200,000	$ 400,000	$ 600,000	$ 1,800,000
Total First Costs & Allowances							
Piers and Mooring Cells	7,329,500	7,329,500	14,659,000	8,265,000	8,265,000	16,530,000	31,189,000
Allowances - Conting., Eng., Superv.	1,773,739	1,773,739	3,547,478	2,000,130	2,000,130	4,000,260	7,547,738
Total Incl. Allowances	9,103,239	9,103,239	18,206,478	10,265,130	10,265,130	20,530,260	38,736,738
Bulk Cargo Handling Equip.	14,500,000	11,000,000	25,500,000	4,750,000	4,900,000	9,650,000	35,150,000
Allowances	1,106,350	839,300	1,945,650	362,425	373,870	736,295	2,681,945
Total Incl. Allowances	15,606,350	11,839,300	27,445,650	5,112,425	5,273,870	10,386,295	37,831,945
Tugboat Service in Terminal	800,000	400,000	1,200,000	200,000	400,000	600,000	1,800,000
Allowances	61,040	30,520	91,560	15,260	30,520	45,780	137,340
Total Incl. Allowances	861,040	430,520	1,291,560	215,260	430,520	645,780	1,937,340
Provision for Added Facilities: Extend Ore Transfer Pier	3,034,413	-	3,034,413	-	-	-	3,034,413
Added Bulk Cargo Equip.: Provision for 2 Additional Deep Draft Ship Loaders or Double Coal Handling to 32,000,000 T/Yr	-	-	-	5,112,425	5,273,870	10,386,295	10,386,295
Total First Costs & Allowances	28,605,042	21,373,059	49,978,101	20,705,240	21,243,390	41,948,630	91,926,731
Interest during Construction Period	1,364,175	1,019,281	2,383,456	987,433	1,013,097	2,000,530	4,383,986
Grand Total First Costs	$29,969,217	$22,392,340	$52,361,557	$21,692,673	$22,256,487	$43,949,160	$96,310,717

Proposed Lake Erie-Ohio River Canal

Lake Erie Terminus - Piers and Bulk Cargo Facilities - Annual Operating Costs

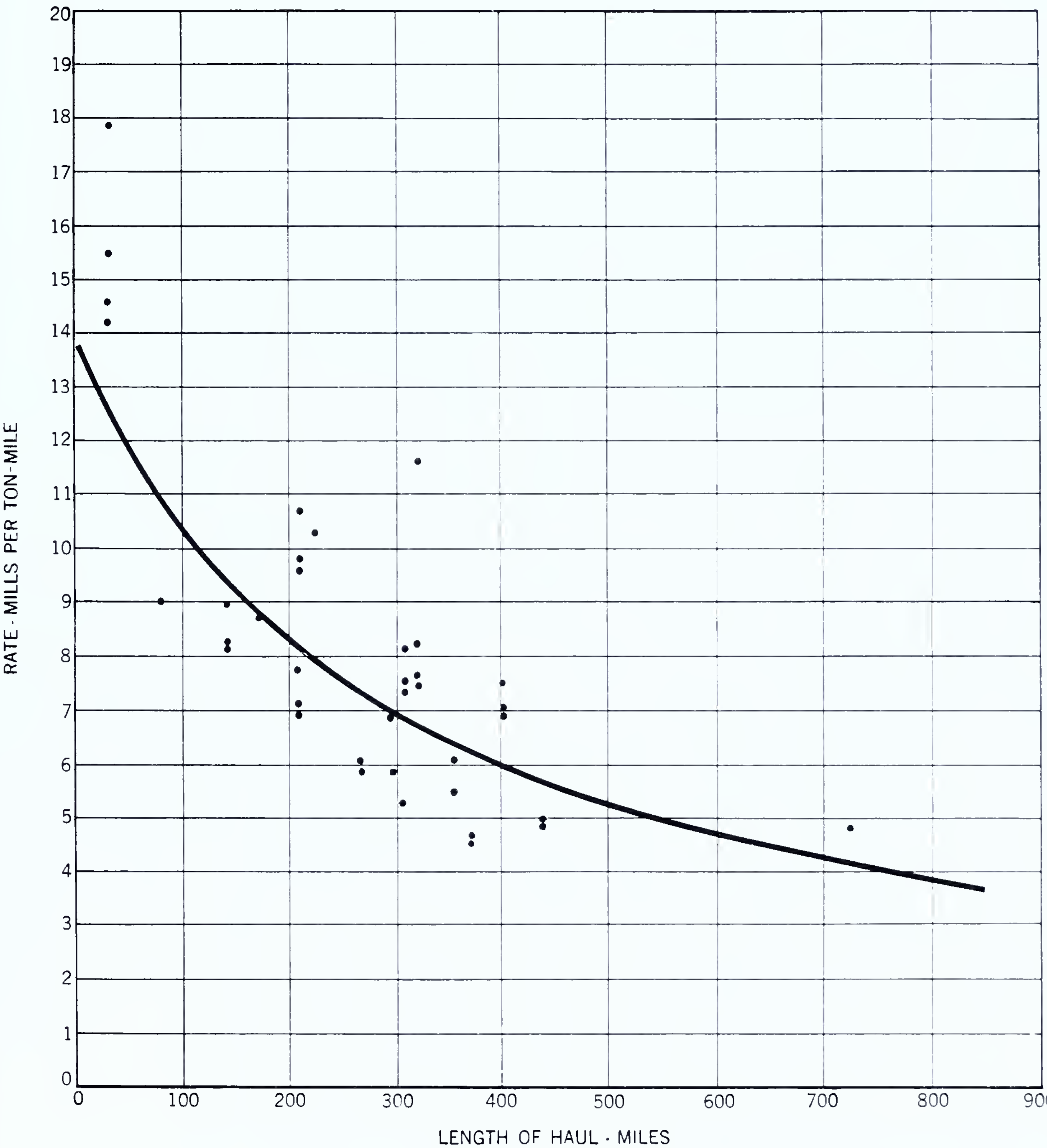
	Ore Handling		Coal Handling	
	Unload Lake Vessels to Barge or Storage	Load Barges from Storage Piles	Unload Canal Barges to Storage	Load Lake Vessels from Storage Pile
First Cost and Allowances	$29,969,217	$22,392,340	$21,692,673	$22,256,487
Annual Costs				
Interest on Investment, 3-1/8%	936,538	699,761	677,896	695,515
Amortization, 0.854%	255,937	191,231	185,255	190,070
Operating & Maintenance Costs	3,124,338	3,502,055	2,953,777	2,675,324
Allowance for Major Replacements	633,614	472,323	204,905	220,819
Cost of Storage	200,000	200,000	200,000	200,000
Total Annual Costs	$5,150,427	$5,065,370	$4,221,833	$3,981,728
Unit Rate Based on 32,000,000 T/Yr	$0.16095/T	$0.15829/T	$0.13193/T	$0.12443/T
Combined Rate				
Ore through Terminal	$0.31924/T			
Coal through Terminal			$0.25636/T	

EXHIBIT NO. 8

PROPOSED LAKE ERIE - OHIO RIVER CANAL

EXISTING UNIT TRAIN TARIFFS ON COAL

Ford, Bacon & Davis
Incorporated
Engineers
CHICAGO NEW YORK SAN FRANCISCO



U-7405 6/9/65 A.R.

Exhibit No. 9

Proposed Lake Erie-Ohio River Canal
Unit Train Tariffs on Coal

To	From	Tariff	Minimum Trainload	Annual Tonnage	Rate per Ton	Mileage	Rate (Mills per Ton-Mile)	Routing
Harlee, Georgia	Arco, Tennessee	SOU 220	5,000	500,000	$1.78	442	4.03*	SOU Macon, Ga. C of G.
			10,000	1,500,000	1.70	442	3.85*	
Federal, Illinois	Percy, Illinois	GM&O 3896	3,500	1,050,000	.68	85	8.00*	GM&O Wood River 1T
Plaines, Illinois	Percy, Illinois	GM&O 3893	7,000	3,300,000	1.30	308	4.22*	GM&O Direct
Waukegan, Illinois	Sherwood, Illinois	C&NW 17160A	9,000	900,000	1.55	177	8.76	C&NW Direct
Baileytown, Indiana	Booneville, Indiana	SOU 211	6,000	400,000	1.84	360	5.11*	SOU Princeton, Ind.,C&El
			9,000	1,000,000	1.60	360	4.44*	Burnham, Ill. CSS&SB
Fayette, Indiana	Linton Dist.,Ind.	CMSTP&P 18590C	2,500	500,000	.68	38	17.89	CMSTP&P Direct
			3,400	748,000	.59	38	15.53	
Fayette, Indiana	Linton Dist.,Ind.	CMSTP&P 18592C	5,900	1,300,000	.555	38	14.61	CMSTP&P Direct
			6,800	1,500,000	.54	38	14.21	
Gary, Indiana	Crown, Illinois	IC 3347	10,000	1,000,000	2.06	215	9.58	IC Matteson, Ill., EV&E
			10,000	900,000	2.11	215	9.81	
			5,000	400,000	2.30	215	10.70	
Gary, Indiana	Belleville, Illinois	IC 3347	10,000	1,000,000	2.30	312	7.37	IC Matteson, Ill., EV&E
			10,000	900,000	2.35	312	7.53	
			5,000	400,000	2.54	312	8.14	
Gary, Indiana	Marion, Illinois	IC 3347	10,000	1,000,000	2.43	324	7.50	IC Matteson, Ill., EV&E
			10,000	900,000	2.48	324	7.65	
			5,000	400,000	2.67	324	8.24	
Gary, Indiana	Madisonville, Kentucky	IC 3347	10,000	1,000,000	2.80	405	6.91	IC Matteson, Ill., EV&E
			10,000	900,000	2.85	405	7.04	
			5,000	400,000	3.04	405	7.51	
Hammond, Indiana	Lynnville, Indiana	NYC 338A	10,000	750,000	1.75	300	5.83*	NYC Direct
			10,000	1,300,000	1.45	300	4.83*	
Midland, Michigan	Minerva, Ohio	Ohio Tariff Bureau No. 28	6,000	900,000	3.82	329	11.61	NKP Toledo C&O
Minneapolis, Minnesota	Harrisburg, Illinois	NYC 328	6,000	200,000	3.50	727	4.81	NYC Chicago C&NW
Machens, Missouri	Herrin, Illinois	CB&Q 20504A	5,000	1,000,000	1.30	145	8.97	CB&Q Direct
			7,000	1,000,000	1.20	145	8.28	
			7,000	1,000,000	1.05	145	7.24*	
Toledo, Ohio	New Lexington, Ohio	Ohio Coal Tariff No. 29	6,000	800,000	2.36	229	10.31	PRR Direct
Oak Creek, Wisconsin	Sherwood Dist., Ill.	C&NW 17162A	9,000	1,100,000	1.52	212	7.17	C&NW Direct
			9,000	1,500,000	1.48	212	6.98	
	Fulton Co., Ill.		9,000	1,100,000	1.64	271	6.05	
			9,000	1,500,000	1.60	271	5.90	
	Springfield Dist.,Ill.		9,000	1,100,000	1.74	375	4.64	
			9,000	1,500,000	1.70	375	4.53	

Note: * Shipper-owned

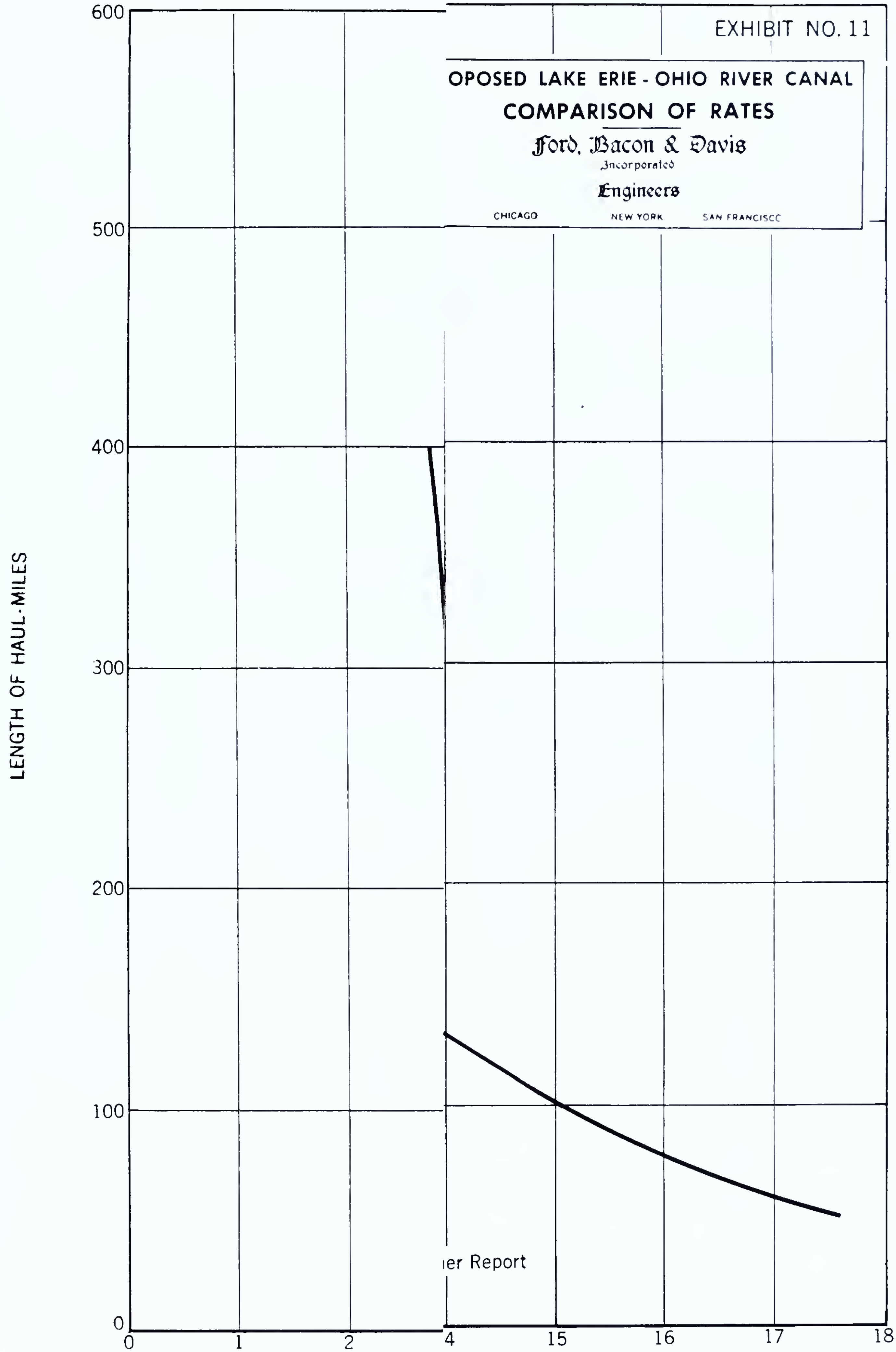
Exhibit No. 10

Proposed Lake Erie-Ohio River Canal

Engineers' Estimated Requirements for Iron Ore, Coal, and Limestone - 1975

(thousands of 2,000-lb tons)

Location of Steel Mills	Iron Ore Requirements			Iron Ore Potential Canal Traffic	Coal		Limestone	
	Total	Foreign	Lake		Required	Potential Canal Traffic	Required	Potential Canal Traffic
Ohio								
Campbell	1,941	990	951	951	2,564	2,564	323	81
Hubbard	273	139	134	-	-	-	45	0
Lowellville	199	0	199	199	-	-	33	8
Portsmouth	1,027	0	1,027	1,027	-	-	171	171
Steubenville	2,283	1,164	1,119	1,119	2,192	-	380	380
Struthers	244	0	244	244	-	-	41	10
Warren	842	0	842	842	1,109	1,109	140	35
Youngstown	2,370	0	2,370	2,370	1,274	1,274	395	99
"	2,642	1,347	1,295	1,295	474	474	112	28
"	674	344	330	330	-	-	440	110
	12,495	3,984	8,511	8,377	7,613	5,421	2,080	922
Pennsylvania								
Aliquippa	2,793	279	2,514	2,514	2,466		466	303
Braddock	3,960	2,020	1,940	1,940	-		660	660
Clairton	489	249	240	240	10,152		81	81
Duquesne	2,001	1,021	980	980	-		333	333
Farrell	982	501	481	-	-		164	0
McKeesport	1,838	937	901	901	-		306	306
Midland	1,196	610	586	586	1,007		199	129
Monessen	1,270	648	622	622	1,251		212	212
Neville Island	874	446	428	428	956		146	95
Pittsburgh	2,813	309	2,504	2,504	1,521		469	469
Rankin	3,345	1,706	1,639	621	-		557	557
Sharpsville	595	303	292	-	-		99	0
	22,156	9,029	13,127	11,336	17,353		3,692	3,145
West Virginia								
Benwood	329	0	329	329	-		55	55
Weirton	3,208	0	3,208	3,208	2,421		535	535
	3,537	0	3,537	3,537	2,421		590	590
Kentucky								
Ashland	1,414	0	1,414	1,414	-		236	236
Total	39,602	13,013	26,589	24,664	27,387	5,421	6,598	4,893



U-7404 6/8/65 A.R.

Exhibit No. 12

Proposed Lake Erie-Ohio River Canal
Potential Traffic

Thousands of 2,000-lb Tons

	1975	1985	1995	2005	2015	2025
Iron Ore	24,664	26,242	27,921	29,708	31,609	33,632
Coking Coal	5,421	5,768	6,137	6,530	6,948	7,393
Utility Coal	29,890	42,106	43,066	44,895	46,308	47,270
Limestone	4,893	5,206	5,539	5,893	6,270	6,671
Steel Mill & Other Products	3,594	4,232	4,949	5,841	6,907	8,132
Total	68,462	83,554	87,612	92,867	98,042	103,098

Potential Savings in Rates (000)

	1975	1985	1995	2005	2015	2025
Iron Ore	$19,534	$20,784	$22,113	$23,529	$25,034	$26,637
Coking Coal	2,299	2,446	2,602	2,769	2,946	3,135
Utility Coal	10,402	14,653	14,987	15,623	16,115	16,450
Limestone	2,676	2,848	3,030	3,223	3,430	3,649
Steel Mill & Other Products	17,711	20,855	24,389	28,784	34,038	40,074
Total	$52,622	$61,586	$67,121	$73,928	$81,563	$89,945